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PLAGUES AND PLEASURES  
OF LIFE IN BENGAL - -







PLATE I.—IN AN INDIAN GARDEN.



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# PLAGUES AND PLEASURES OF LIFE IN BENGAL

BY

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## P R E F A C E

IT has been pointed out to me that the title of this volume is more or less a *guet-apens*, and that some definite information regarding the nature of the "Plagues and Pleasures" to which it refers ought to be given to the unwary reader, lest he should waste his time in the quest of stirring tales of tiger-hunts, pig-sticking, and snipe-shooting, or humorous anecdotes illustrative of the peculiarities of human beings, only to find that the narrative deals solely with the ways of some common invertebrate animals and the characters of certain tropical plants and seasons. It must at once be confessed that there is nothing of an exciting nature in the following pages, the contents of which consist in a great measure of notes accumulated during the course of many happy years in India; but at least it may be said in their favour that they are not founded on the shifting sands of memory, and represent the outcome of contemporaneous records of careful personal observations.

It is not the happy fate of all Europeans in India to meet with hair-breadth escapes or thrilling adventures ; but most of them have spare moments of leisure from official and social duties which might be profitably and happily spent in the study of the nature and habits of the common animals and plants of their adopted country. It is quite true that a taste for Natural History is in great measure an inborn endowment, but it is one which is originally present in very different degrees of development, and which may long lie dormant unless it have been encouraged in the youth of its owner. But even the feeblest germs of it may be called into activity at almost any time of life ; and, to any one who has ever realised the joy of the “hours of quiet breathing” which it brings with it, it is almost a duty to strive to share the boon with others, and thereby to introduce them to “troops of friends,” whose numbers steadily increase with the flight of time, who never change, never grow any older, but return year after year in immortal youth.

TORMOUNT, TORQUAY,

*May 1st, 1907.*



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## ERRATA

Page 51, line 32, for *rufognigra* read *rufonigra*.

„ 78 „ 22 „ *bryophillums* „ *bryophyllums*.

„ 252 „ 32 „ *Jasminium* „ *Jasminum*.



# PLAGUES AND PLEASURES OF LIFE IN BENGAL

## INTRODUCTION

There is no creature so small and abject, that it representeth not the goodness of God.

THOMAS À KEMPIS.

THE beasts, birds, and other vertebrate animals frequenting Indian gardens are more apt to attract careless observation than their invertebrate associates, and hence usually appear in the foreground of the mental pictures which survive the destructive influence of prolonged absence from the places in which they were formed, whilst lower phases of animal life are very likely to be remembered only as causes of annoyance or of exceptional and startling displays of beauty on a large scale. Vivid memories of nights when sleep was rendered impossible by innumerable bites, stinging like the pricks of little red-hot needles and announcing the irruption of hosts of red ants; of evenings on which the air was all a-flutter with the gauzy wings of aspiring termites, or rendered dreadful by swarms of monstrous flying cockroaches or legions of evil-smelling "green bugs" may remain to compete with those of great stretches of jungle brave in the flaunting wings of countless gorgeous butterflies, or

blazing up fitfully under the consentaneous flashing of thronging fireflies,—visions of such exceptional events may persist; but, as a rule, the common, small experiences of a life spent among myriads of strange and interesting creatures are very soon curiously blurred when they cease to be of daily occurrence.

Even when much attention has been directed to them, the need of some contemporaneous record of results is still more urgent here than in connection with the study of the life-history of higher animals. The mere size of retinal images seems to affect the duration of visual memory, images of large dimensions giving rise to more lasting mental impressions than those produced by smaller ones, probably because they stimulate a larger number of sensitive elements. This alone would have been enough to enforce the necessity for immediate record of observations on minute animals, but the need is greatly enhanced by the bewildering abundance and variety in which such organisms occur and the corresponding multiplication of distracting and conflicting impressions which they occasion. A very little trouble and perseverance is, however, enough to furnish endless amusement for spare moments and to secure a record which, in after times and altered surroundings, may serve to revive the conviction that, without their multiform and multitudinous population of insects and other small creatures, tropical gardens would be wanting in much of their interest and æsthetic value. The following pages are founded on notes gathered during the course of twenty-nine happy years in



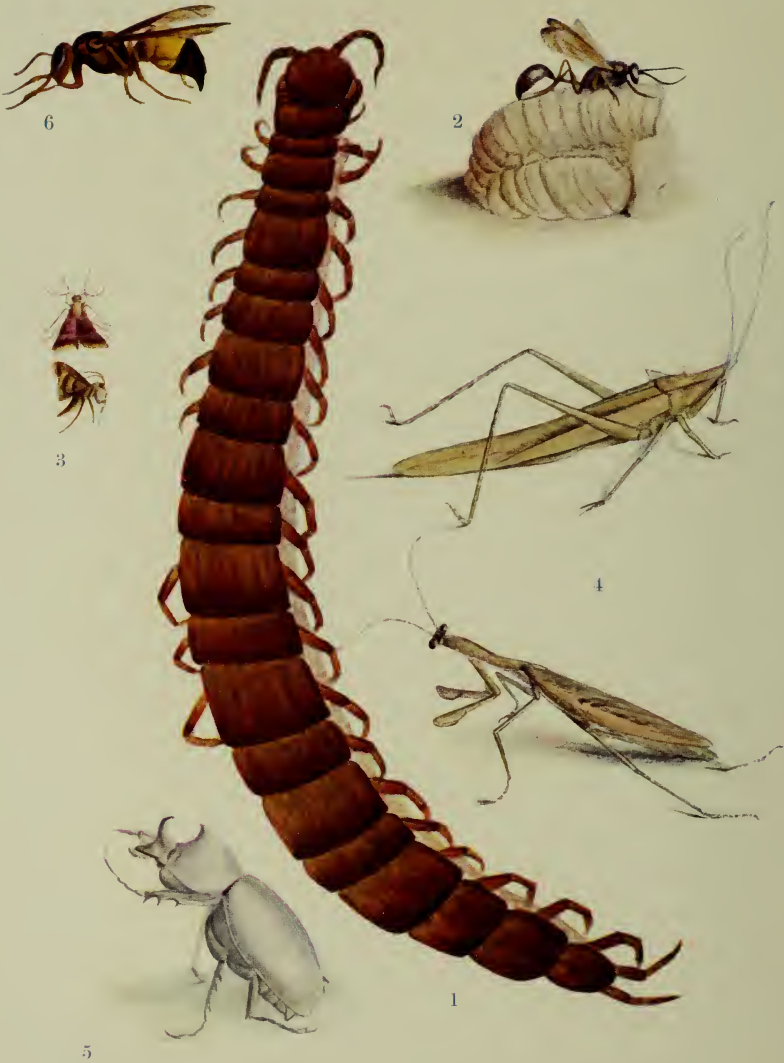
India. They were originally put together for the sake of the purely selfish pleasure of recalling golden hours and experiences of a period "when hope and health were strongest," but they will serve a more worthy end should they in any degree help to advertise a source of ceaseless interest and occupation for the leisure hours of others who are still fortunate enough to be residents in the "delicious East."



PART I  
THE SMALLER INMATES OF  
HOUSES AND GARDENS







# UNINVITED GUESTS.

- Fig. 1. Common large Centipede which sometimes enters houses : exact natural size.  
 " 2. Solitary Wasp with clay nest.  
 " 3. Small Moths which infest the combs of hornets.  
 " 4. Cricket and Mantis : showing characteristic colouring during periods of drought.  
 " 5. Stridulating Beetle.  
 " 6. Common large Hornet, of Calcutta.

## CHAPTER I

### WASPS AND BEES

Cric—Cric—I think I hear the wasps o'erhead.

*Pippa Passes.*

The soft, small unfrighted bee.

*Sordello.*

When, his thighs with sweetness laden,  
From the meadows comes the bee.

*Fly Leaves.*

VERY few tropical insects invite attention more insistently than various kinds of wasps and bees. They rarely boast of the superb dimensions and wonderful colouring of moths and butterflies; but they are sometimes strikingly beautiful, and are almost always highly attractive owing to their amazing energy and intelligence and to the facilities which their familiar, not to say intrusive, habits offer for intimate acquaintance. Butterflies only accidentally stray into houses, and though many different kinds of moths often enter them in order to immolate themselves before the shrines of lamps and candles, or as ungrateful guests who abuse hospitality by injuring the property of their entertainers, they never yield the funds of dispassionate interest and amusement which are constantly provided by intrusive hymenoptera.



The moths, whose larvæ play havoc among treasured furs, carpets, or costly embroideries, doubtless supply endless occupation in attempts to limit their ravages; but their manners and customs are by no means alluring, and the injuries which they inflict are too serious to form a subject for philosophic contemplation. But when solitary wasps come bustling in to convert keyholes into nurseries and larders filled with grubs or spiders and plastered up with clay; or a bee insists on converting the pencil-holder on a notebook or sketching-block into a series of cells, separated by earthen walls and stored with glutinous honey,—the injury is trifling and easily remedied, and the interest attending observation of the means by which it is effected far more than makes good the temporary inconvenience connected with it. It is an easy matter to protect rarely used keyholes by gumming strips of paper over them during the season at which they are likely to be invaded; the presence of their proper contents will always secure pencil-holders from attack, and should they have been left unguarded and joyfully appropriated, very little trouble is enough to restore them to their normal state. It would, then, be indeed churlish not to welcome the loudly humming notes which annually herald the onset of summer and announce the arrival of hosts of eager creatures hurrying round in search of suitable sites for their nests, or labouring along under the burden of loads of clay or stores of provisions for their larders.

One of the commonest solitary wasps to visit

European houses in Calcutta is a relatively large insect, clothed in a suit of rich, warm brown, and with a brilliant yellow head. The hot weather has barely had time to assert itself before insects of this kind begin to hurry in through the widely open doors and windows to explore the surfaces of chairs, tables, and other pieces of furniture in eager quest of convenient foundations for their buildings. Their search does not usually last long, as they are not troubled by any shyness or desire of seclusion, and are very catholic in their choice. Any fairly smooth wooden surface seems to satisfy them, and, when a site has once been fixed upon, they are quite ready to encounter frequent disturbance and repeated obstruction in the course of their work rather than abandon it in favour of any new and, as it might have been supposed, happier one. Should a spot on one of the drawers of a writing-table in constant use have been chosen, the builder may at times seem to be somewhat puzzled by the frequent movements to which it is subject; and when the top or sides of the well have been preferred, the presence or absence of the knees of the owner may give rise to passing bewilderment. But, in spite of this, the work goes on unless it be violently interrupted; and even then, even when the outcome of much time and toil has been ruthlessly done away, attempts to replace it are often perseveringly repeated again and again before the idea of giving in dawns upon the mind of the indefatigable architect. In such circumstances it is fortunate that the insects are very little inclined to use their really formidable jaws and stings save

in securing materials for building or in paralysing the caterpillars with which they store their cells; it would be no joke to have an irascible British wasp insisting on building on a writing-table.

The cells are highly finished structures, and are laid down in the shape of rows of little earthen pots with short necks. The chamber which is first built, and which sometimes remains solitary, has a body of evenly rounded contour, and presents a strong likeness to a miniature specimen of one of the common earthenware *gahrās* used by the natives of India for holding water, milk, or other liquids; but where a row of cells is constructed, all but the first are more or less compressed, because one wall is supplied by the side of the preceding member in the series. In consequence of this it is only in the first cell that the cavity is a rounded one, whilst in all the others it is narrow and bounded by walls which on one side are convex and on the other concave according as they present towards the beginning or end of the row. Each group of cells thus comes to take the form of a ridge of clay with fluted sides, convex ends, and an upper surface bearing a line of projections, corresponding with the necked openings of the individual cavities before they have been sealed up. The convex ends of the ridge, of course, represent the outer and disengaged walls of the first and last chambers in the series.

The builders of these structures, like all their nearest relatives, have very long and strong legs, which are specially adapted to facilitate the work of building and storing their chambers. It is owing

to this peculiarity that they are able to carry about great lumps of clay or bulky caterpillars firmly grasped by the front pair of limbs, whilst the others remain free and make it easy for them to alight and to carry out all the complicated movements which are called for in constructing and filling the cells. The amount of work which is put through in a very short time is truly astonishing, and well fitted to excite wonder at the store of energy which must be laid up within the bodies of the labourers, who have no hankering after Eight Hours' Bills or other artificial restrictions to interfere with their ceaseless activity from early dawn until far on into the dusk of the late evening. When a wasp has once settled down to build, she seems hardly to allow herself a moment's rest, and to have no thought of anything save continuous and strenuous toil until her whole set of cells has been finished, stored, and sealed up. I was once hard-hearted enough to kill a worker, who had just brought in a pellet of wet clay to an unfinished cell. She weighed four grains and her burden one and a half, a load equivalent to one of over fifty pounds to a man of ten stone in weight; and these figures do not, of course, represent the relative expenditure of effort in the two cases, seeing that the insect carries her load through the air. A weight of fifty pounds is a fair load for a healthy man, even for a comparatively short time, but the insects go on continuously hurrying about with their burdens from dawn to sunset, save during the brief pauses called for by the work of plastering. It is always interesting to notice the fierce energy with which the work of



building is conducted while the insect holds on to her edifice by means of her four hinder legs, clasps the clay between the front pair, and, with these and her strong jaws, moulds and spreads it, filling the air as she does so with loud, shrill humming.

The construction of each cell—that is, of each but the first one of a series, which naturally takes somewhat more time, because it is built up without any help from pre-existing ones—occupies about three hours; for example, a cell which was begun at 7.30 a.m. one morning was finished by 10.45. After the walls have been built up and curved inwards above so as to leave only a small opening, this is surrounded by a prominent ridge, which at first is vertical, but is afterwards turned outwards whilst the clay is still plastic. In order to secure this the worker thrusts her head well down into the opening, presses her chin firmly against the ridge, and then spins rapidly round and round, humming loudly as she goes. When satisfied that the work has been thoroughly done, she withdraws her head from the opening, closes her wings, turns right round, and finally thrusts her long-stalked abdomen down into the inside of the cell in order to attach an egg to one or other point on the walls a little beneath the level at which they begin to curve inwards. The business of laying is usually finished within a couple of minutes, and then the mother wastes not a moment on rest, but at once rushes out in quest of stores of food to stock the larder of her expected child.

The time spent over this part of her labours naturally varies greatly with the quantity of suit-

able prey which she meets with, and the distance at which it lies ; but in any case it extends over some hours, and may sometimes last for several days. In favourable circumstances, a cell which has been finished early in the forenoon may be fully stored by the following evening ; but even when this is the case, it is not usually closed until the next morning. The contents invariably consist of green caterpillars, long, green "loopers" being apparently regarded with special favour. Each cell, after having been stored, is finally sealed up by means of a thick plug of clay, which is easily fitted into place owing to the out-turned edges of the rim surrounding the opening ; and no sooner has this been done than the insect begins to build anew.

The clay which forms the walls of the cells very soon sets, and becomes so hard that it seems strange that each chamber should not become a vault in which the wasp which is developed within it is permanently entombed ; but, as a rule, the fabric readily yields under the energetic assaults to which it is exposed from the strong jaws of the young insects when their proper time for emerging has come. This, however, is by no means invariably the case, and it is not uncommon to find certain of the chambers, in a row of cells from which most of the inmates have long since escaped, containing the shrivelled mummies of insects who have not been strong enough to work their way out. Whenever a young wasp matures it forthwith sets about attacking some point in the walls of its nursery, rasping down the clay with its strong jaws so as to convert it into fine powder which

falls to the bottom of the cell or, after perforation has taken place, descends outside to form little heaps on the surfaces of any objects beneath. On first escaping from their prisons the young insects are usually thickly coated with dust, and spend some time in cleaning themselves and stretching and airing their soft and crumpled wings before launching out into flight.

When a mother-wasp has finished a row of cells to her satisfaction, she no longer remains in constant attendance, but, in certain cases at least, she certainly continues to exercise some supervision over it. In one case, which was specially watched, the opening by which a young wasp had escaped from its cell in the morning was carefully sealed up again during the course of the next few hours; and on the following day, when the new plug had been removed and another cell containing an immature insect had been partly opened, the damage was in both instances promptly made good. The inmates of a row of cells usually escape at intervals of two or three days' duration, but the exact length of the pauses between successive exits naturally varies with the time which was spent in building and storing the individual chambers. Where the rows are exceptionally long, it sometimes happens that, whilst the indefatigable mother is still hard at work at one end, her eldest children are already emerging at the other.

Throughout the whole course of building the strictest economy of labour is observed. Should the surface which has been chosen as a foundation be a rough one, its inequalities are carefully levelled



up by a layer of clay ; but when it is smooth, such a flooring is omitted and the walls are started directly from it. The sites chosen for building are usually stable ones, but a heedless architect will now and then make an injudicious selection, and I have known an instance in which a row of cells was established on the edges of the closed pages of a book.

Almost as common as the wasp whose habits have just been described is another intruder who invades houses at the same time of year. She is a beautiful black and yellow creature, with a peculiarly long and slender waist, and, like her relative, comes in, not in quest of prey, but in order to look for convenient places in which to build. Her cells are of a somewhat rudimentary nature, and consist of simple tubes, rounded off at one end and remaining fully open at the other until they have been stocked and are ready to be sealed up. They are sometimes attached to wooden surfaces, but oftener to the plaster of roofs and walls, where, during the course of the casual processes of repair conducted by native workmen, they are often covered by layers of whitewash as though they formed an integral feature in the building in which they are situated. Their structure as well as their form is rather rude, for the walls are not evenly plastered, but show a series of ridges and furrows corresponding with the successive layers of pellets of clay which have been worked up into them. Moreover, they often show very distinct evidence of waste of material ; and in cases where several tiers of cells have been laid

down, the masses of clay heaped up around them frequently make the whole structure look more like an amorphous lump of dried mud than the result of elaborate architectural effort. It is noteworthy that this defective talent for building is not the only sign of inferior mental evolution in these insects; for they do not seem to have fully realised the advantages which their long and slender waists confer upon them, seeing that they think it necessary to go completely down into the interior of their cells in order to lay, and must thus expose themselves to quite unnecessary risks of being taken unawares. Each cell when finished receives an egg, and is then filled with spiders and sealed up. Spiders of many different kinds, so long as they are of suitable size, seem to be equally acceptable, and the process of storing does not take long. Cells from which the young insect have escaped are very often sealed up anew, but whether this repair is aimless or implies renewed use I do not know (Plate II.).

Many other sorts of solitary wasps abound during the hot weather and rainy season, and some of them are almost as constant visitors in European houses as the two insects which have just been described. There is one small creature who has a depraved love for empty tobacco-pipes, and, on finding one, carefully plugs the inner end of the stem, builds a partial ceiling across the upper part of the bowl, deposits an egg and store of spiders in the chamber and then closes it with more of the same shining, white cement used in her earlier works and seemingly obtained

from the limewash of neighbouring walls. The temptation to punish the intrusion by a practical jest is almost irresistible; it is so easy to remove the pipe from the rack or other place which it occupies, and so amusing to observe the astonishment of its tenant when she returns to find her nest gone, and wanders round in perplexity until it is replaced and joyfully recognised. In this and many other cases the amount of actual building which is called for is very small. In it the cell can be completed by the introduction of a small plug below and a thin ceiling above, but a little more work is necessary where the spaces which are chosen are either open tubes or tunnels of more or less acutely elliptical outline; for, in the first case, a complete floor must be laid down, and, in the second, parts of the walls have also to be supplied. The crevices abounding in loose bundles of papers, and the larger spaces often present at the backs of books, or between the pages of carelessly treated ones, are very often appropriated by wasps bent on nesting. A brilliantly metallic creature once took to infesting my laboratory, humming and buzzing about in seemingly great anxiety. At intervals her music ceased and was replaced by a strange, shrill, rustling sound, which appeared to issue from a large file of papers, and, on opening this up, a clay-nest was found to be wedged in between two of the sheets. Its cavity was of a roughly tubular contour, and was subdivided into a number of shallow cells, separated by clay partitions and filled with spiders of many different species, one

of them in each chamber, having a white, glistening egg firmly attached to its body. In this case the ends of the nest and the partition-walls had been wholly built up by the wasp, but the walls were in great part formed by the neighbouring surfaces of paper. The amount of building required for the completion of the cells in such situations necessarily varies considerably with the exact contour of the spaces which have been chosen. Where these are nearly tubular mere cementing layers of clay will serve to complete the walls by fixing the opposite surfaces of paper to one another; but when the original cavity is acutely elliptical, walls of some thickness must be built up in order to do so.

Besides those who invade houses with a view to nesting in them, other kinds of solitary wasps often appear as casual visitors, who are generally in search of spiders and common domestic insects; and out-of-doors myriads of them are ceaselessly roaming round with tireless energy. Hosts of slender creatures—some banded in strong dead colours, and others gleaming in metallic radiance of green, blue, or ruddy gold—are for ever hastening about as though possessed by very devils of activity and impatience, causing them, even when otherwise at rest, to go on perpetually flicking their wings to and fro under the influence of sudden explosions of nervous force. One of the most conspicuous of them is a very large, fierce insect, with a body shining in metallic lustre of deep blue and green, and wings which cast fiery golden reflections from their polished



surfaces. It is often to be met with rushing to and fro over gravelled walks or dry earth, and is now and then tempted to enter houses in search of the great cockroaches who infest them, and who seem to be a highly valued prey. Indeed, they are so often used as a source of food for the larvæ that the natives of India look upon the mature wasps as affording unequivocal examples of transmigrations in which the vital essence is transferred from one organism to another and quite different one. It is quite exciting to watch a wasp of this kind fiercely quartering round over a road, her wings quivering and her antennæ trembling with eagerness. Should she come across any small mound of loose earth cast up by some desirable burrowing insect, she instantly throws herself upon it, tears up the soil with her jaws, and shovels it aside by means of vigorous kicks, so that within a very short time she has almost disappeared in the excavation. Every now and then she backs out to take a run over the surface, and should another heap present itself, her attention is often distracted, and a new attack undertaken ; but, as a rule, it is soon abandoned, and she returns to labour away at the first place until she either secures her prey or gives up the business in despair, and flies off to some new hunting-ground. Specimens of another species are sometimes to be seen clasping great fat spiders to their bosoms whilst they run quickly about over the floors of rooms in a way which would be impossible were it not for the length and strength of their legs.

One very small wasp is always on the outlook

for deserted combs of the common yellow hornet, and, with shrill humming, appropriates the empty cells, stores them with eggs and food, and roofs them in with a bright red material apparently consisting of fine brick-dust worked up into a cement. Surfaces of loose earth are constantly haunted by many different kinds of wasps, sometimes as places in which nests may be dug out, but oftener as preserves abounding in spiders and small insects. One of these diggers is particularly handsome owing to the brilliant vermilion colour of its body, which makes a bright patch among the dull grey and brown tints of the surrounding soil. In another species sober hues prevail, the body being banded in black and white, so as to be hardly visible whilst the insect is at work; and it is fortunate for such a persevering miner that this should be so, as she is a small and somewhat feeble creature, and requires all the aid of protective colouring to save her from attack whilst partly buried in shallow tunnels or backing out of deeper ones. She digs most energetically, scraping out the soil with her forelegs, and tearing off little bits of it with her jaws. All the time, however, she is keenly alert and nervously apprehensive of being taken unawares. Every now and then she interrupts her work in order to clean herself from dust and have a sharp look round for any impending danger. The tunnels are soon carried to such a depth that the workers completely disappear within them, only backing outwards at intervals in order to discharge loads of earth over the edges of the openings.

An almost endless field for interesting study presents itself in connection with the curious differences in habit, and of what we can hardly but regard as intellect, which are to be met with among the members of this group of insects. In some cases we find them building up highly elaborate edifices almost entirely by their own efforts; in others selecting sites in which their ends may be attained with minimal toil; and in some of these, seeming to fail to reap the full benefit of their choice and expending needless time and work under the influence of a persistent instinct for independent architecture even where there is no longer any need for it. It is an open question whether instances in which cells are independently built, or those in which they are in great part formed by neighbouring surfaces, should be regarded as indicating a superior degree of mental endowment in the builders. A more elaborate technique is called for in those cases in which whole cells are built up, but a higher sense of the advantage of economy of labour is clearly indicated by the choice of sites in which very little need be done in order to complete them.

Of the social wasps occurring in houses and gardens in Calcutta, much the commonest are the so-called "yellow hornets," who so constantly enter rooms and so often build up their great combs beneath the sun-shades of windows and on the beams and shutters of verandahs. They are quite as abundant and intrusive as the common wasps of the British Islands, but luckily have none of their vicious irritability, so that it is rare indeed to hear



any complaints of injury attending their visits. During the many years which I spent in India I was only once stung by one of them, and then the assault was certainly committed in circumstances which rendered it a very venial offence. The wonted mildness of these wasps naturally gives rise to toleration of their presence and to a tendency to treat them in very off-hand fashion, and my misadventure took place in consequence of this. One morning, when a number of them were flying about over the breakfast-table and were being roughly brushed aside if they came too near, one was accidentally caught between two of my fingers, and not unnaturally resented the pressure and made free use of her sting. Even on the rare occasions on which such an event occurs, little harm follows, as the venom is so feeble as to cause very little pain or swelling. Just as in England, the onset of the cold weather is the season at which there is the greatest risk of stings, because the insects are then stupid and sluggish, and at the same time much inclined to infest the interior of houses in search of sheltered nooks in which to hibernate. I was once much startled when, on suddenly removing a quilted cover which had for some time been thrown over a large microscope, I found that the inner surface was tenanted by a large colony of wasps who had taken up their winter-quarters there. It is, therefore, always well at this time of year to be prepared for their presence in unexpected places, and to exercise some caution in handling the fringes of pankhas, the folds of table-cloths, and the cushions of tables and chairs.

During mid-winter they are hardly ever visible, but many survive and are ready to come out from their lurking-places. Whenever the temperature rises steadily with the arrival of spring, they begin to appear, and by the middle of March they are already busily building. In most cases the work is started by a single wasp, but sometimes two or three take part in it from the outset. A copartnery of three insects was certainly concerned in the foundation of a comb which was once built in a screw-pine in the portico of my house. When first noticed the comb consisted of six shallow, saucer-like cells, each of which contained an adherent, white, oval egg. A fortnight later the work was still being carried on by the three original wasps, and no young ones had yet come out, but the first cells had been considerably deepened, and several new ones had been added to them. Even later, when the comb had become comparatively large, it still remained in the hands of the three old insects. The first few cells were firmly attached to a leaf by means of a tough, flexible stalk of a shining brown colour and a texture quite unlike that of the paper forming the walls of the chambers. The stalks by means of which the combs are attached always present these characters, and, as originally laid down, form the stems of the first cells, each of which, thus, for a time looks like an inverted egg-cup. As fresh cells are added to the comb the stalk is made a little thicker, and for a time seems to be fairly proportionate to the body which is suspended from it; but as this increases in diameter and

thickness, and is loaded with young wasps, it soon appears strange that the slender cord should be able to bear such a massive and heavy burden. As time goes on the combs often become very thick, and many of them attain diameters of many inches in extent, but, in spite of this, they remain firmly attached, although their pedicles have not been appreciably thickened, and no secondary ones have been added to reinforce them.

The combs are usually fixed to the under surfaces of large, strong leaves, such as those of palms or screw-pines, or to the beams and laths in the roofs and shutters of verandahs, and are rarely to be met with actually within the rooms of European houses. Now and then, however, a wasp will find the store of building-material provided by the woodwork and paper in a room too alluring to be neglected, and will begin to build there. One which had yielded to this temptation came to an untimely end in my book-room shortly after she had set to work. She elected to build in one of the lockers of my writing-table, which she could readily enter whenever the door was left ajar, and which contained an abundance of convenient brown wrapping-paper. Her work had gone on for some time gaily, and whilst rasping away noisily at the handy stock of paper she was doubtless congratulating herself on the wisdom of her choice, when unhappily one of the servants, in the course of doing out the room, tightly closed the door at a time when she was within the locker ; and when I opened it a few days later she was already lying dead and dry beneath her unfinished comb.

The combs are not provided with any special covering, but they are little liable to injury from rain, as the mouths of the cells always face directly downwards, and the under surfaces of the leaves or beams to which they are attached project over them, so as to be very efficiently protective. The walls and inner or upper ends of the cells are formed of tough grey paper, which is somewhat thicker on the upper surface of the comb than in the partitions separating the individual chambers. The following characters were presented by one large comb which was taken whilst additions were still being made to it. It was nearly circular in outline, with a diameter of five inches and a depth of two and a half in the central and thickest part. The disc was suspended from a twig beneath a thick awning of the polished, leathery leaves of an *Ixora* by a slender, shining, almost black stalk about half an inch in length. It was formed of cells, some still open below and tenanted by eggs and larvæ, whilst others were sealed up, and contained pupæ or young wasps almost ready to emerge. Even in the thickest part of the comb only a single tier of true cells was present, but they were of considerable depth and subdivided into several superimposed chambers by partitions of silky webbing attached to the side-walls. In the case of the outer or lower chambers, especially those which were still empty or only contained ova, the partitions were usually firmly attached all round; but in some of them, and in all the deeper ones, they had been converted into hinged valves, owing to partial separation from the paper of the walls



These structural peculiarities are the outcome of the fact that the parent wasps do not waste time in waiting for the emergence of the successive broods of young ones from the cells, but go on continuously adding to the depth of the latter, and depositing new eggs in their lower or outer ends, so that at different depths within the tube of a single cell a recently deposited egg and a young wasp may be met with simultaneously. So long as any young one retains the larval stage, and must be fed, its cell must of course remain open; but when it is about to pass through the series of changes leading to maturity it retires to the deeper part of its chamber, and then spins a silky web attached to the walls and shutting off the open end of the tube. The originally simple cell is now subdivided into two chambers—the inner one containing a young insect, and the outer one shallow, open, and at first empty. The parent wasps at once proceed to deepen the outer chamber by adding fresh stores of paper to its walls, and whenever it has attained a suitable depth an egg is deposited within it. The egg is attached to some point on the side-walls, and presently hatches a grub, which has usually become of some size before the older insect in the inner chamber is ready to come out. Its bulk, however, is not sufficient to prevent the escape of the young wasp after it has converted the partition closing its chamber into a hinged door by gnawing through the silky tissue along one part of its attachment to the paper walls of the tube. The grub in the outer chamber must of course be squeezed and

pushed about whilst its relative forces its way out, but afterwards finds itself just as it was before being hustled; for the tissue of the partition is quite strong enough to form a continuous inner wall to the chamber even after it has been partly separated from its attachments. As processes of this kind are repeated, the tubes of the combs gradually lengthen, their deeper portions being occupied by valved and empty spaces, and their outer ends containing closed chambers inhabited by young wasps, and open ones in which are grubs or eggs. In many cases, however, the combs are tenanted, not only by their proper inmates, but also by the larvæ, pupæ, and imagos of a beautiful little moth, whose wings are painted in delicate shades of ochre and brown-madder (Plate II.).

It is easy to secure good specimens of the combs of such mild and good-tempered creatures as these yellow wasps are, but even in taking them it is just as well to call in the aid of fumes of hydrocyanic acid. By means of them perfect specimens of the nests of the most militant bees and hornets may be obtained without difficulty and with no risk so long as the operator avoids incautious inhalation. It must, however, be borne in mind in regard to nests obtained in this way that, whilst the reagent is certainly and fatally toxic to all the mature insects and to any young ones contained in open cells, it does not usually penetrate sufficiently into the interior of closed chambers to slay their inmates, and that these are likely to continue emerging for some time, and to occasion a temporary plague in their new environment until they have all escaped.

In the case of the comb described above, the surface of the disc as it lay on my work-table was for some days constantly peopled by young wasps cleaning themselves and stretching and drying their wings before taking flight. One of the simplest and safest ways of using hydrocyanic acid is to hang a wide-necked bottle containing lumps of good cyanide of potassium to the end of a fishing-rod, a long billiard-cue, or any stick of sufficient length, and then add some strong nitric acid. The only points to be specially attended to are to avoid inhaling the fumes as they issue from the bottle, and to take care that the salt used is of good quality, for in the tropics it is apt to be converted into a harmless carbonate unless it has been carefully preserved from free access of air. When such an apparatus has been rigged out it is an easy matter to convey it to the immediate neighbourhood of the nest or comb which is to be treated, and then to pass the end quietly and gradually onwards until the mouth of the bottle lies immediately beneath it. The results are very striking, especially in cases in which large, flat, unprotected combs are being dealt with. As the owners come streaming in with stores of food and building materials and enter the area occupied by the deadly vapour, they suddenly collapse and drop downwards, dead or stupefied, in a continuous shower. Even in dealing with the most savage insects there is no risk of injury so long as perfect immobility is maintained, for the nest is wholly undisturbed, and the immediate development of intoxication prevents the victims from inquiry into its origin.



Very much handsomer, and also very much more aggressive insects are the great brown and yellow hornets (Plate II.) who often come hawking into rooms in search of prey or building materials. Their combs are not simple, exposed structures like those of the yellow wasps, but are protected by a strong wrapper of rough brownish paper, which in colour and texture is very like that commonly used in drying botanical specimens. In their earlier stages, and whilst the comb or combs remain comparatively small, the outer covering of the nests has the form of an inverted flask, prolonged beneath into a tapering neck, and with the cells suspended from the inner surface of the dome. A nest in this condition was once fixed to the under surface of a bough of a *Bougainvillæa* in my garden, and when taken contained a single comb of cells tenanted by grubs, chrysalids, and glistening white eggs adhering by one end to the walls of their chambers. As the number of insects in a colony steadily increases, a nest of this nature soon ceases to provide sufficient accommodation for the growing masses of comb, and the form of the outer covering is accordingly modified. One very large nest which I took formed a great cone around the stem of a shrub which passed up through it so as to play the part of a roof-tree. The lower and broader end was thirteen inches in diameter, and the total height of the cone was about eighteen inches. The walls were, as usual, composed of coarse, brownish grey paper, and the cavity contained sixteen tiers of combs separated by narrow inter-spaces. Building begins on the onset of hot

weather in spring, and the number of builders goes on steadily increasing until the early part of the following winter.

These wasps seem to be more purely carnivorous than the common yellow ones, and are rarely to be found visiting flowers or fruits even when the latter cover the ground beneath trees haunted by fruit-bats and have been conveniently mangled before they fell. They are usually too fully occupied in hawking after animal prey to have any time to waste on vegetable delicacies, but there are certain kinds of flowers whose stores of nectar prove too seductive to be neglected and are appropriated in characteristically brutal fashion. The long tubes of *Hamelia patens* contain large quantities of nectar in the lower parts of the corollas and are hence frequently plundered by honeysuckers and various kinds of insects. Most of these visitors do no harm to their hosts, and the honeysuckers, at any rate, amply repay their hospitality by conveying pollen from flower to flower and securing cross-fertilisation; but the hornets are mere burglars; for, as they are far too bulky to travel down the narrow tubes and have not tongues long enough to reach the level at which the nectar lies, they make a short cut by biting out a piece of the walls.

The broad fringes of aquatic grasses and other weeds round the edges of ponds are for ever haunted by hornets roaming round ready to descend upon the eggs which imprudent dragon-flies may have laid above the surface of the water, or on one or other of the countless spiders and small

insects who inhabit the jungle. They do not even spare their own near relatives in the course of their forays, and I once found a party of them eagerly rifling the comb of a colony of yellow wasps, which I had been watching from the time when it consisted of two or three cells until it had become a disc of several inches diameter, attended by a host of busy and happy workers. One morning, on approaching the group of cannas in which the comb lay, I was surprised to see numbers of wasps sitting idle and dejected on the neighbouring twigs and leaves, whilst others, who were coming in from distant hunting-grounds, suddenly drew up when close to the nest and flew outwards as though terrified. Their behaviour was so strange as to be almost alarming, and it was with some caution that I ventured to investigate its cause. The first glance beneath the overarching leaves was enough to solve the problem, for it showed that the surface of the comb was crowded by hosts of marauding hornets who were savagely tearing open the cells, dragging out young wasps, grubs, and ova, and either devouring them on the spot or hurrying off with them towards their own settlement. Such a scene of brutal pillage could only be likened to those which were wont to attend the sack of towns in mediæval warfare. The furious energy of the robbers was quite terrifying as they came streaming in, fell to work tooth and nail, and then hastened off laden with booty. In the evening I removed the comb, on which a few disconsolate wasps were sitting as though stupefied by their calamity. It presented a woeful aspect; the cells were everywhere broken

and tattered, those in the central parts of the disc being almost completely destroyed, and all save one or two empty—a solitary grub and a few stray eggs were all that remained to represent the flourishing nursery of the previous day.

During the course of their ceaseless hunts for prey, brown hornets very often enter rooms and go drifting about, buzzing loudly, and every now and then coming unpleasantly near any one who may happen to be present at the time of their incursions. Moreover, they are so reckless in their flight that they are very apt to rush violently against projecting beams in the roof, or the surfaces of pankhas, and then fall headlong and in the worst of tempers on any object, human or other, which may chance to be below. Under such conditions their presence is open to grave objection, and it is always well to have efficient means of dealing with them at hand. One of my laboratories in Calcutta was particularly subject to their visits, and, as it is almost impossible to carry on continuous microscopical observation or delicate processes of preparation whilst quivering under the nervous stimulation provided by the presence of a noisy and ferocious creature, I became quite an expert in getting rid of them. After much consideration and experiment I came to the conclusion that a tennis- or racquet-bat is by far the most efficient weapon in conflicting with objectionable flying insects of any considerable size, as by means of it they can be cut over at a safe distance and either killed outright or so much knocked out of time as to be temporarily helpless and easy of



despatch. I never had any personal experience of the toxic value of the venom of these hornets, but, judging by the amount of it which they have at command, and the size of the weapons by means of which it is administered, it is probable that their stings may give rise to serious injury. The natives of India certainly believe that they do so, and have a very strong dislike to the presence of any colonies of hornets in their immediate neighbourhood, whilst they regard those of common yellow wasps with contemptuous indifference.

Another and very handsome hornet, who occasionally visits houses in Calcutta, is a great creature of a deep red colour. An individual of this kind once took to frequenting my bedroom for several days. She must apparently have belonged to a colony established in the immediate vicinity, for her visits were repeated very often, and on one occasion she appeared again and again, embracing a large grey maggot, and could hardly be persuaded that her nest was not somewhere in the room. It was interesting to observe how she held her prey—back downwards and firmly grasped round the neck—and how viciously she bit it every now and then to put a stop to any attempts at escape.

In many parts of Upper India the common brown hornets of Calcutta seem, to a great extent, to be replaced by splendid creatures who are comparatively rare in Lower Bengal, and usually only appear there during exceptionally dry seasons. In them the thorax is of a rich bright brown colour, and the abdomen almost black, banded and tipped

by vivid canary yellow. Unlike their brown relatives they are singularly placid, good-tempered beings; and it is fortunate that they should be so, for, during the midday hours of the season when the fiery blasts of the hot wind prevail, they very often take shelter in large numbers in the relatively cool and moist air of bathrooms in a way which is somewhat disconcerting to bathers unused to their manners and customs.

Bees of many kinds and often of great beauty abound in Indian gardens, and some of them frequently build their combs within the rooms of inhabited houses. All through the course of the hot and rainy seasons a solitary bee is apt to give trouble owing to the desire it has to appropriate any small tubular cavities as sites on which to lay up masses of sticky brown honey separated by thin layers of clay, and various other species are always on the look-out for any convenient and secure nooks in the woodwork of furniture. One enterprising and courageous creature selected a site in the bowels of a small but sinfully noisy cuckoo-clock, and continued to visit it regularly, undeterred by the vehement ticking, the ceaseless motion of the wheels, and the outrageous clamours of "the monstrous fowl" when he came forth to insist upon the flight of time.

Most of the common bees to be met with in gardens are very inoffensive neighbours; but it is always well to resist the establishment of any colonies of the fierce and irritable insects, whose huge combs, blackened by thronging workers, are so often a terror when hanging from the vaulting

of domes and archways in the most interesting tombs and masjids in Upper India, or even from the roofs of railway stations, where their owners seem to be quite indifferent to the prevailing hubbub and to frequent exposure to dense clouds of steam from passing engines. Rather formidable in appearance but really very innocuous creatures are the great carpenter-bees, brave in polished armour casting metallic reflections of deep blue, vivid green, and fiery gold and bronze, who scoop out catacombs in the stems of dead trees, and are for ever coming blundering into neighbouring houses, filling the air with deep-toned humming, and dashing recklessly up against the walls and roofs. During winter they almost wholly disappear, but when spring brings continued and steadily rising heat they once more emerge from their fastnesses, and very soon are as conspicuous and intrusive as ever. Though really meaning no mischief, they are apt to be somewhat alarming to nervous people from the way which they have, like the common large humble bees of English gardens, of wheeling around the head of any one who approaches their settlements, coming closer and closer with each successive circuit, and humming aloud with most tryingly reverberative energy. Their threatening demonstrations are, however, mere bluff, and it is quite safe to approach a colony so closely as to have full opportunity of studying all its humours. It is a quaint show to observe shining foreheads and gleaming eyes appearing out of the gloom of the caverns as workers hurry upwards to launch out into the air, or to note the



way in which those who come home with stores alight and hasten into the narrow tunnels. Every fine evening a period of general excitement sets in. As the sun goes down, and just before the community retires for the night, scores of bees are to be seen flying far aloft in pairs who seem to be making violent love. Whilst a colony is in full activity the ground beneath the tree which it occupies is always thickly strewn with sawdust, and during the day workers are constantly to be seen toiling up backwards to the mouths of the caverns and shunting loads of rubbish over the edges; whilst, on the surface of the bark around, numbers of young insects, who have just emerged for the first time, sit drying and stretching their small creased wings and clearing their bodies from adherent fragments of yellow web.

These great bees seem to be very efficient in securing cross-fertilisation in the flowers of the large *Thunbergias* (Plate III.), for they are constantly to be seen visiting them in quest of nectar and pollen, which they obtain by means of honest, front-door entrance, and not by any burglarious violence like that applied by the brown hornets to the flowers of *Hamelia*. There are many things to render the presence of a large colony of them welcome even in the immediate neighbourhood of a house; but it must be allowed that it is open to two objections—for, in the first place, the heaps of débris cast out of the tunnels are apt to have a very strong and disagreeable smell during continuously wet weather; and, in the second, the proper inmates of the community are very often



PLATE III.—A MASS OF THUNBERGIA.



accompanied by hordes of highly unsightly commensals. These are seemingly either beetles or cockroaches of large size, repulsive aspect, and dull vermilion colour ; but their unpleasant aspect and sluggish movements render them so exceptionally "base and degrading" that I never had the courage to examine them closely as they sprawled and drowsed in the mouths of their caverns.

One of the most charming of the common garden-bees is an exquisite little creature, whose short, stout body is painted in alternate bands of shining black and the brightest, purest cobalt. It is usually to be met with solitarily, but now and then several specimens will be lured together by the charms of some specially seductive flower. It would be hard to imagine a more fairy-like sight than that of a party of them hovering about within one of the great blooms of a night-flowering cereus. The brilliant blue and black of their bodies shines out in startling contrast with the surrounding golden whiteness of the corolla while they fly freely around in its cup, and every now and then dash suddenly downwards to snatch masses of pollen from the radiant, yellow anthers. Their action in gathering pollen is quite characteristic ; the patiently laborious accumulation by means of which most bees obtain their loads being replaced by a succession of sudden descents and clutches. They have another peculiar habit in common with some kinds of parasitic bees of settling down for the night hanging by their jaws, or by these and their fore-legs, from the under surfaces of sloping straws or blades of grass. During the course of the rainy



season numbers of them may often be found at sundown hanging in this way from the grass-thatching of plant-houses. Sometimes each individual swings in solitary state, but oftener two or three, and sometimes as many as seven of them prefer to hang close together on a single blade. The first-comers usually seem to be very inhospitable and resent the arrival of their would-be neighbours. Whenever a fresh insect draws near and hovers about in search of a good place to fix on to, all its predecessors at once become much excited and warn it off by brandishing their hind legs up over their backs, just as a common humble-bee does when interrupted whilst rifling an alluring flower.

Many of the exposed combs which are to be found in almost every garden in summer and autumn are really beautiful objects. Those belonging to one very minute kind of bee are particularly admirable; arranged in a series of flattened discs, built up of slender cells full of clear brownish honey, and strung upon an axis consisting of an upright twig.

In any region abounding in bees, wasps, and other irascible stinging creatures it is always well to know the best means of dealing with injuries inflicted by them. Every one knows of the palliative and curative properties of ammonia and blue-stone, but when these reagents are not at hand some whitewash scraped from the surface of the nearest wall, or the freshly cut surface of an onion, will be found an excellent substitute. Far more efficient than anything else in dealing with

the stings of bees and wasps is ipecacuanha-powder, a material which is almost sure to be present in any well-ordered Indian house. It certainly acts like a charm in allaying the pain of the most virulent stings, even that caused by scorpion-venom rapidly yielding to it. The only objection to the treatment is that even the external application of the powder over a very large surface may sometimes give rise to the symptoms ordinarily following its ingestion. A friend of mine once suffered from extreme and depressing nausea for many hours after he had applied large quantities of the powder to the skin of his head, neck, hands, and arms, which had been badly punished in an encounter with bees in a garden in Ahmedabad.



## CHAPTER II

### ANTS

Along the furrows, ants make their ado.

BROWNING.

La fourmi n'est pas prêteuse,  
C'est là son moindre défaut.

LA FONTAINE.

SURELY the human race can never be too thankful to ants! How many hours of blissful "distractions" and "paresse" have they afforded to others besides that lovable and disreputable old person le bon-homme La Fontaine, who once, when upbraided by a friend for being late for dinner, replied: "Je viens de l'enterrement d'une fourmi; j'ai suivi le convoi jusqu'au cimetière, et j'ai reconduit la famille jusque chez elle."

On reviewing one's acquaintance with them, a curious medley of impressions arises, memories of occasions of absorbed interest jostling those of excessive nervous irritation. Hours of happy observation may be spent in the study of their ways so long as these do not interfere with personal comfort or the integrity of treasured possessions; but when they involve sleepless nights, severe bodily injury, or the frustration of horticultural hopes, they can hardly be looked upon with dispassionate interest. There are some ants who invite active

aversion by their ill-temper and nasty habits, but it would be hard to regard most species, so long as they will not insist on playing the rôle of uninvited guests, with anything save tolerance, if not with friendship. Almost all of them are apt to be mischievous in gardens, but there they are in their own domain, and it is only when they persist on leaving it and intruding into human habitations that any just ground for active animosity arises.

In tropical gardens a very brief experience is enough to show that they are an inevitable evil which must be constantly looked for and resisted. There is no saying where a colony may not elect to take up its quarters, and it is certainly most annoying to find pet plants wilting and drying up because their roots have been ruthlessly cut away by tunnels, or the pith of their stems and branches cleared out to make room for a formicarium, and it is almost as bad to become aware that seeds are no sooner sown than they are gathered up and stored away in granaries before they have had a chance of germinating. Moreover, even when they are not engaged in public works of any great magnitude, ants are so diabolically energetic and so ruthlessly eager in their quest of food for themselves and their larvæ as to render them causes of ceaseless apprehension.

Each successive autumn, when the time comes round for sowing the seeds of European annuals dear to the exiled mind from their tenderly cherished suggestions of bygone days and English gardens, and when the pans have been carefully filled and stocked, it is always necessary to keep a sharp look

out in case they should be regarded as mere handy depots of food for the use of neighbouring colonies of ants, and to be ready to lavish turmeric powder over the soil on the first signs of invasion. In cases like this, however, it must be allowed that a temptation has been wilfully laid out, and that, if foreigners elect to import outlandish delicacies and spread them broad-cast over the highways, it is clearly at their own risk ; but it is hard to maintain an attitude of judicial tolerance when foraging parties or even whole communities violently invade houses. Even where the intruders are not actively mischievous and abstain from any personal assaults on their hosts, they may be very annoying merely on account of their numbers. It is very unpleasant to become aware that one is being used as a parade-ground for regiments of little crawling creatures ; to find that a sugar-basin contains an impartial mixture of ants and its proper contents ; or that a sponge vomits swarms from all its pores ; but any exasperation connected with such events is nothing compared to that which is experienced by any one who is roused in the middle of a hot night to the knowledge of the fact that the bearer has neglected to keep the saucers beneath the feet of the bed supplied with turmeric or water, and has, therefore, left a set of open thoroughfares for the passage of hosts of vicious little red fiends ready on the slightest provocation to announce their presence by bites or stings of cruel power.

The sites selected by different kinds of ants for their settlements are very various. Many species, like the commoner ants of the British Islands, make

their fastnesses underground, and sometimes heap up great mounds over them with materials derived from their excavations, or gathered from the surface around. In other cases the dead wood of stems and branches is preferred, and an intricate system of tunnels and passages hollowed out within it, while sometimes living plants are invaded, the pith being scooped out or the cavities of normally hollow tissues appropriated. One very curious species establishes colonies within the cavities of the fruits of figs at the time when they are so far matured as to furnish sufficient house-room and abundant stores of saccharine food; others love the interspaces between the stems and sheathing leaf-stalks of palms, and subdivide them into sets of apartments partitioned off by walls of chewed wood; and some have a depraved liking for the crevices in files of papers, and enliven the dullest official correspondence with swarms of minute inmates smelling almost as strongly of castor-oil as Nubians do after they have freshly anointed themselves with that alluring cosmetic.

Some ants really make their headquarters high aloft in bambus or among the branches of trees. One common species constantly builds large round nests of a papery material, containing ova and young in all stages of development, among the sprays of clumps of bambus, in the tangled masses of creepers, or on the stems of tall Papayas; but, in very many instances, the curious structures, built up out of leaves tightly bound together and lined by sheets of webbing, which appear so conspicuously in thinly foliaged trees, are not the permanent sites of



colonies, but are mere larders or cow-houses containing stores of food or herds of aphides yielding honey-dew. This is invariably so in the case of the leafy shelters built by the common large yellow ant (*Æcophylla smaragdina*) among the foliage of mangos, mahoganies, and other trees infested by aphides. At certain times of the year almost every mahogany tree near Calcutta is disfigured by numerous spherical masses consisting of leaves bent down over one another and bound together by layers of thin white webbing. At first the entangled leaves look as green and healthy as any of the surrounding ones, but in a short time they dry up, wither, and become brown, so as to render the masses very conspicuous. Some caution is called for in any attempts to examine their structure, for their proprietors are very fierce and always on the alert to resent intrusions on their privacy. They do not sting, but are ever ready to inflict acrid bites, which smart as though they were caused by strong acids or red-hot metals. If one of the edifices be gently stirred up with a walking-stick, hosts of excited yellow creatures at once issue out through all the crevices on its surface, brandishing their antennæ aloft in search of the cause of disturbance, and, should this not have been promptly removed, streaming down along it to assault the hands and arms of the holder. Any of them, too, who may chance to fall to the ground in the course of the scuffle seem at once to realise the state of affairs and proceed to show their displeasure by such determined onslaughts as to render hasty retreat advisable. If, therefore, the observer

have any serious intention of examining the structure and contents of one of the masses, his best plan is to break or cut off the sustaining bough suddenly, and, letting it fall to the ground, retire to a safe distance and wait there until the outraged insects have deserted their treasure, which they usually do very soon after the catastrophe. When they have gone and the mass has been laid open, it will be found to consist of a thick layer of leaves and web surrounding a central cavity containing neither ova nor young ants, but only a number of large aphides adhering to the bark of the twig which forms the roof-tree of the building, and to the petioles of the leaves which are bent over and woven into its walls; the buildings, in short, are not nests but cow-houses.

They are built up very gradually, but are in many cases of very considerable size. Originally they are formed of a few neighbouring leaves, bent down and tied together by tough white webs so as to form a penthouse over a small group of aphides; but, as time goes on and the herd rapidly multiplies whilst the first set of leaves withers and dries up, it becomes necessary that larger stabling and fresh stores of fodder should be supplied, and with this more and more leaves are added until the edifice attains an imposing magnitude. The leaves of mahogany trees are so divided and flexible as to lend themselves very readily to the construction of such enclosures, but, in certain cases, highly alluring aphides infest trees with such rigid and resistant foliage that much more labour is called for, and great interspaces have to be filled up by sheets of webbing.



These common yellow ants are highly catholic in respect to diet, and I have seen them eagerly collecting immature crabs who had imprudently swarmed out of the Hugli at a point of the bank near the headquarters of a colony. Now and then they are lucky enough to light upon an exuberant store of prey, and when such an event occurs in places remote from their fastnesses they at once realise the necessities of the case, and, in order to reap the full benefit of their good fortune, forthwith set about building temporary larders to contain their booty until there be time to dispose of it permanently. When the monstrous male fruits of *Ficus Roxburghii* mature and begin to vomit forth myriads of crawling and flying insects, the event is very soon discovered by the scouts belonging to any neighbouring colonies of yellow ants. Even before the walls of the fruits have been fully perforated, and therefore long before any fig-insects have emerged, numerous eager ants, probably warned by the sounds made by the strong jaws of the males whilst rasping out tunnels of exit in the walls of their prisons, may be seen wandering round in excited expectation over the surface, listening intently at the points beneath which the work of excavation is going on, and ready, whenever it has been completed, to bend over the openings of the caverns and pick out the workers as they struggle up. So long as the store of prey arrives gradually it can be readily disposed of by direct portage to the headquarters of a colony; but presently the openings in the figs become freer as one after another of the awkward,

lumbering male insects comes gnawing upwards, and by the time that the agile, winged females are ready to emerge, the tunnels are wide enough to allow them to do so in continuous streams.

The ants have now to face the evils of an embarrassment of riches, and, if they are to secure their windfall, can no longer afford to make long journeys in garnering it. Of this, however, they are fully aware, and so, whilst some of them go on diligently drawing on the stream of prey, others set about in frantic haste building temporary store-rooms from neighbouring leaves. Where any small and pliable foliage is handy the task is an easy one, as the blades can be readily brought together, but, in its absence, even the huge, rough, rigid leaves of the fig itself are made use of. Here it is not a case of merely bending and tying mobile leaves; the two resistant halves of one and the same blade must be forced upwards until their edges approach one another enough to be fastened together by web so as to form the walls of a chamber. It is hard to imagine how the task is accomplished, even by such energetic and intelligent workers, but somehow or other it is carried out, and, very soon after a fruit has begun to disgorge its load of insects, the neighbouring boughs bear store-houses stocked with heaps of corpses and defended by vigilant warders ready to repulse any intrusions. The fig-leaves which are used in such cases are always folded upwards from the line of the midrib, because this is the direction of least resistance and causes the two halves of the blades to resume the position which they normally held

in the earlier stages of their development. Unlike the leaves used in the formation of shelters for aphides, they seem to be in no wise injured by the treatment to which they have been subjected, probably because they are not clothed by any continuous sheets of web and have their lower and most importantly respiratory surfaces turned outwards and freely exposed to the air, in place of facing inwards to the confined spaces whose walls they form, as is the case with the blades used in the construction of cow-houses.

The emergence of a swarm of winged ants is always an interesting event, both on account of the behaviour of the insects themselves and because of the attractions which it offers to many birds and other animals as a source of abundant and alluring food. It is always interesting to note how many different kinds of birds take to playing at fly-catchers when a swarm is on the wing; and, indeed, it often happens that attention is first attracted to the event by unwonted peculiarities in the flight of certain common birds. The same thing may sometimes be observed in England, especially as regards starlings, who, for the time being, may be seen flying round in wide circles and every now and then interrupting their sweeping courses by curious little fluttering ascents of essentially fly-catching character in order to secure aspiring ants. In the British Islands, however, the commonest examples of a temporary assumption of the habits proper to fly-catching birds are probably those furnished by the numerous instances in which many kinds of small birds take to mimicking

wagtails in running and darting about over a lawn from which numerous insects are emerging.

A colony of savage little red ants which had established itself in my garden in a complicated system of tunnels excavated in the thickness of an upright wooden post covered by a growth of *Vanda teres* once gave off a winged swarm on a hot, still evening in autumn. As I happened to be close at hand at the time, I was informed of the event before any birds had begun to assemble by the eccentric behaviour of a yellow jumping-spider, who was disturbed and alarmed by the rushing streams of excited ants who were pouring out of the openings in the wood and spreading out over the surface of the bark. She went on leaping hither and thither in search of a quiet place, and presently, after having tried whether suspension at the end of a thread might not yield it, threw up the sponge and made tracks for a less lively neighbourhood. The surfaces of the post and the stems of the orchid were thronged by crowds of red wingless creatures hurrying round in the wildest excitement, but only a limited number of winged ones were visible. These emerged slowly and awkwardly from the openings in the wood, paused for a short time, and then made their way upwards to the tips of the *Vanda* twigs, spread their wings and floated off into the air. Two very distinct kinds of winged insects were present—one of small size and dark brown colour, and the other much larger and of a reddish yellow tint. They continued to come out and stream away for some time, and so long as they did so the



excitement among their wingless relatives lasted, but whenever they ceased to emerge the stir subsided, and very soon the surfaces of the post and the branches of the orchid were deserted. On the following evening similar events took place. On both occasions many of the wingless insects behaved as though they objected to the emigration of their companions, seizing hold of their wings and hanging on obstinately so as to hamper them in their attempts to take flight. As rain was on both evenings beginning to fall, and harbinger the arrival of a heavy thunderstorm, they may have thought the existing conditions unfavourable to migration, and so tried to persuade their reckless relatives to put off their excursion to a more convenient season.

When the atmospheric conditions are favourable the emigrants float upwards into the air like a light cloud of smoke, so thin and transparent that it might easily escape notice, were it not for the behaviour of the swifts, who come streaming in in screaming flocks, and the peculiar evolutions of many other kinds of birds, who are attracted to assemble on the surrounding ground and trees by the toothsome stores of food. All the neighbouring boughs and twigs are soon occupied by a varied troop of competitors, who behave like bee-eaters or king-crows, making short outward flights to seize feebly fluttering insects, and then turning short round on widely spread and seemingly motionless wings to sail back to their perches.

Many kinds of true ants seem to be almost as averse to crossing open and exposed surfaces as



“white-ants” are. When any colony of insects with this peculiarity has decided to establish a highway across a garden path the workers are not content to clear a track from gravel and other superficial obstacles, or even to dig out a hollow way, but convert the latter into a tunnel by roofing it over with a layer of clay.

The flowers of many different kinds of plants are constantly haunted by ants who find their stores of nectar and pollen as attractive as bees and butterflies do, but, unless in the case of very small flowers, they can hardly aid in securing cross-fertilisation to any appreciable degree. When the scarlet bracts begin to flame out on shrubs of *Euphorbia pulcherrima*, the flowers which they surround and whose maturation they advertise are constantly visited by swarms of ants eagerly competing with great butterflies in attacks upon the stores of clear, glistening nectar filling the cavities of the curious fleshy glands beneath; but whilst the butterflies are forced to serve in transferring the pollen of the male flowers to the stigmas of the female ones, the ants can secure their booty without coming into contact with either.

Every part of a tropical garden is almost constantly alive with ants in bewildering numbers and variety. Some of them are so irascible and provided with such formidable weapons as to inspire profound suspicion; even a casual encounter with a few stray individuals of such aggressive creatures as the common black and brown *Sina rufognigra* is to be avoided, but in order to acquire a really

due respect for them it is necessary to have been guilty of trespassing on one of their strongholds. I have been driven to drop recklessly from a considerable height in a tree tenanted by a colony, and I shall never forget the results of offending one which had established its headquarters within the stems of a group of Cordylines. The poverty-stricken character of the foliage had for some time shown that the plants were unhealthy, and I accordingly set about pruning them freely in the late dusk of an autumn evening. The work had, however, to be hastily abandoned, for hardly had a few shoots been divided before my hands and arms were covered by enraged ants who avenged my intrusion by biting and stinging so viciously that I was unable to bend my fingers for several days.

Fortunately all ants are not so vicious or venomous as those just mentioned, for it would be indeed terrible were all the larger species haunting tropical gardens of like malignity. Many of them are in fact such inoffensive creatures as to lend strong support to Dickens' theory of the correlation of large size with amiability if not feebleness of will in the giants of shows, but there are others whose morose disposition renders them very undesirable neighbours. The bathrooms of some houses are apt to be infested by monstrous black ants with huge jaws, which they are only too ready to use on the arms and legs of unwary bathers; and their bites are really serious injuries, for they are not simple incisions, but involve the removal of solid lumps of tissue and copious hæmorrhage. Another and relatively innocent

species confines itself to the open air, and is often to be met with hastening up and down the stems of trees in the course of excursions from a labyrinth of burrows in the ground below. The recesses between the great "plank-buttresses" of silk-cotton trees seem to be specially favourite sites for colonies, and the black bodies of their inmates stand out in startling relief as they bustle up and down over the silvery grey surfaces of the bark. These ants are wonderfully active, and, though usually very inoffensive to human beings, are highly nervous and irascible in their behaviour to one another. Processions of them are constantly wandering about over the bark, carefully examining all the irregularities of its surface, but seeming to meet with small return for their trouble. Their great heads and upturned abdomens give them a staggering gait, and seem to drag them downwards whenever they attempt to descend at a rapid pace. They are so nervous that whenever two of them absorbed in their own affairs happen to jostle one another they immediately turn sharp round and exchange furious glances. Every now and then one who is rushing headlong down from above scatters insult and injury broadcast all along her course, and when, as often happens, a general panic sets in and all the excursionists make a simultaneous bolt for the ground, numberless collisions and momentary hostile encounters add to the prevailing confusion.

It would be easy to multiply the record of occasions on which ants of many different kinds have been sources of interest and wonder from the

peculiarities of their ways, the ingenuity with which they adapt themselves to unwonted environments, and their wonderful co-operative action in dealing with difficulties; but it is needless to do so, as there is nothing to be said regarding these features in tropical ants which has not already been picturesquely related of European ones, and it is enough to point out that, however fully and attractively such events have been chronicled and studied, the actual experience of their occurrence must always excite admiration and delight.

In many Indian gardens ants and other small creatures are constantly exposed to the risk of perishing in the pitfalls of so-called "ant-lions," who dig their snares in footpaths and other open places. The pits are often very abundant and the source of much entertainment either when a heedless victim strays into them, or when the indignation of their owners is aroused by the practical jest of rolling small stones down the treacherous and sliding slopes, to be at first joyfully greeted as booty, and then angrily rejected when their true nature has been discovered.



## CHAPTER III

### FIG-INSECTS

Der liebe Gott könnte uns recht in Verlegenheit setzen, wenn er uns die Geheimnisse der Natur sämmtlich offenbarte, und wir wüsten vor Untheilnahme und Langeweile nicht, was wir angefangen sollten.

GOETHE.

THE wonderful correlation between the presence of certain insects and the maturation of the fruits and seeds of most kinds of figs is certainly one of "the fairy tales of science." It implies the antecedent occurrence of a series of evolutionary adaptations of bewildering complexity and elaboration which in many cases have been pushed so far as to have given rise to such intimate interdependence between the animal and vegetable organisms in which they have taken place that, were either of these to be abolished, the other would almost inevitably perish—in the absence of suitable insects the development of any fertile seeds in the fruits of the figs would become a rare and quite exceptional event, and in the absence of suitable fruits the insects would die out because they could no longer find suitable sites in which to deposit their eggs and spend the greater part of their lives.

The fruits of figs, as every one with an elementary acquaintance with botany knows, are complex structures consisting of an outer case or "receptacle"



representing the widely expanded and incurved end of a fertile twig, and a layer of flowers covering its inner surface. The surface which bears the flowers is so much rolled upwards and inwards, that what is structurally its upper face comes to form, not only the floor, but the sides and roof of a cavity which opens upon the outer world only by means of a narrow channel or "ostiolum" at the apex where the incurved edges of the receptacle approach one another like those of a bag when drawn inwards by means of a cord. An arrangement of this kind would in itself have served to seclude the flowers greatly, but it has been reinforced by the fact that the sides of the ostiolar opening are everywhere thickly clothed in a layer of scaly bracts which project inwards from the opposing surfaces and overlap one another so far as practically to close the canal to any intruder who is not prepared to struggle inwards in spite of formidable obstruction. The width of the canal and the nature and number of the obstructive bracts varies considerably in the case of different kinds of figs, and with this the degree to which the cavity containing the flowers is protected varies proportionately. In cases in which the edges of the receptacle are relatively thin, do not approach one another very closely, and are not provided with many layers of highly developed bracts, the cavity may be comparatively easily reached, but where the opening is narrow and traverses thick masses of tissue clothed in dense tiers of overlapping and glutinous scales, entrance can only be effected by dint of persevering and strenuous exertion, and

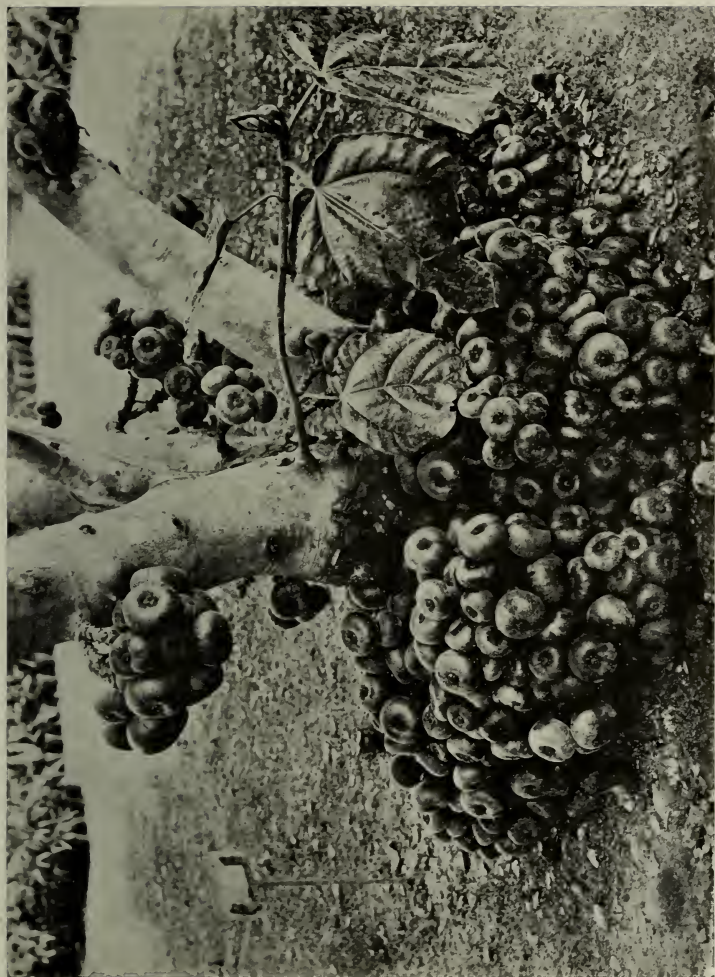


PLATE IV.—A MALE TREE OF *Ficus Roxburghii* WITH MATURE GALLED FRUITS.



with this the number of successful intruders must necessarily fall.

Were the flowers in the interior of the receptacular cavities always hermaphrodites in which the stamens and stigmas matured simultaneously, or did each cavity contain simultaneously maturing male and female flowers, the intervention of any external agency such as that of insects would of course be unnecessary, or at all events the access of a very few insects might be all that was necessary in order to secure the extensive pollination of stigmas and the development of fertile seeds in normal fashion; but in fact the flowers are not hermaphrodites, and in many cases staminiferous and normal pistil-bearing flowers never occur within the same cavities, and yet abundant crops of fertile seeds are constantly being produced within fruits which only a very few insects have been able to enter, and then only under conditions rendering it practically impossible that they should have succeeded in carrying any appreciable amount of pollen with them whilst forcing their way in through the numerous and resistant obstructions of their passage.

In those figs in which the process of differentiation has been carried farthest, two distinct kinds of fruits are present, borne on two different sets of trees. *Ficus Roxburghii* (Plate IV.), a species with very large fruits, affords an example of this condition. In it the fruits on one set of trees contain only normal female flowers capable, under certain conditions, of producing fertile seed, whilst those on another and quite distinct one never produce any normal female



flowers, but only crops of male ones and of peculiarly modified females incapable of producing seeds but adapted to the reception of the ova of insects and forming sites in which the latter may pass through all the stages of development preceding maturity. Such female flowers have been so profoundly modified as to render them quite unable to perform their original functions and at the same time specially fitted to play the part of foster-mothers to young insects.

At an early stage in their development the two kinds of fruits in *Ficus Roxburghii* differ little in outward aspect, but those which contain normal female flowers are usually somewhat flatter than the receptacles occupied by male inflorescence and the peculiarly modified females, or "gall-flowers," as they have been well named from the relation which they bear to the insects to whom they afford shelter and nourishment. Even from a very early period the interior of the receptacular cavities shows very conspicuous differences in the two cases. In normal female fruits the walls of the cavities are evenly and finely granulated throughout, and very soon acquire a bright tint of rose madder owing to the growth of a uniform coating of flowers, each of which contains a single ovule, and bears a long, club-shaped, rosy stigma. But in the other kind of fruits two very distinct floral areas are present occupied by flowers of wholly unlike characters. Immediately beyond the lowest layer of scales, which clothe the walls of the passage leading to the outer surface and project into the cavity so as to form a prominent ridge,



lies a narrow band of flowers which eventually produce stamens; but the rest of the surface is clothed in a dense layer of strangely transfigured female flowers, in which the normal elongated clavate stigmas have become transformed into short stiff trumpets arising from the bodies of ovaries of exaggerated size and with abnormally thin walls. It is the latter peculiarity which renders these flowers specially adapted to the reception of the ova of the fig-insects. In the normal female flowers the walls of the ovaries are so thick and of such resistant texture as to present an insurmountable obstacle to the penetration of the ovipositors of the insects to the softer tissues within, but in the gall-flowers no such resistance is encountered, and the eggs are easily placed in sites favouring their evolution.

The fruits, whether containing normal female flowers or male and gall-flowers, go on steadily growing up to the time at which their contents have arrived at a certain stage of development, but when they have acquired a diameter of about two inches their growth ceases, and, unless insects invade them, processes of withering set in, soon followed by fall without the production of any seeds or perfect pollen.

In fruits of either kind which are ready for the reception of insects, the canal leading from the outer surface to the cavity containing the flowers remains firmly plugged by a dense mass of adhesive scales, which not only completely close the lumen of the tunnel owing to the way in which their inner edges overlap, but form a prominence at its deeper end where the lower layers project into the

floral cavity, and are succeeded by a narrow band of smaller bracts passing outwards to the first row of flowers. In the case of fruits containing male and gall-flowers the greenish yellow ring of bracts is surrounded by a narrow band of white where embryonic pollen shines out through transparent membranous coverings and contrasts with the pale pink of the styles and trumpet-shaped stigmas of the modified female flowers clothing the rest of the walls of the cavity. In fruits containing only normal female flowers the white staminal ring is naturally absent, and the whole of the walls of the cavity beyond the area occupied by bracts is covered by a continuous stratum of bright rosy, club-shaped stigmas rising from a corresponding sheet of ovaries (Plate X.).

Should insects fail to enter fruits at this stage of development no farther evolution takes place in the flowers ; no mature pollen is produced by the anthers of the young stamens, and the ovaries of the female flowers, whether normal or modified, remain unaltered until withering sets in. For a time the flowers hold on in hope of the arrival of insects, and then they gradually fade and dry up along with the walls from which they arise. But should insects be at hand and succeed in forcing their way into the fruits before withering has set in, a series of important and conspicuous changes soon begins to declare itself.

Almost immediately there is evidence of a great rise in the tide of ascending sap and of proportionate hypertrophy in the walls and contents of the invaded fruits. In the case of those containing

male and gall-flowers, the receptacle enlarges rapidly ; its walls increase in thickness ; its cavity, which was previously empty, becomes filled by an accumulation of liquid which rapidly acquires a brownish purple hue from pigment macerated out of the tissues of the flowers ; and both male and gall-flowers begin to grow apace. The filaments in the males lengthen and push the anthers out of the membranous hoods which previously covered them, and the embryonic pollen begins to mature, the so-called tetrads breaking up and ultimately liberating perfect grains. At the same time the eggs which have been deposited in the ovaries of the gall-flowers hatch out, and while the young insects are maturing the floral tissues around them grow so vigorously that there is soon no room for their accommodation when spread out in a single layer. In consequence of this the flowers gradually become arranged in several strata in which the ovaries are provided with stalks of different lengths. Finally, and just before the insects are about to escape from the flowers, the liquid contents of the cavity dry up and disappear, leaving the interior of the fruit once more empty.

In fruits containing only normal female flowers a parallel series of changes follows the access of insects, only the accumulation of liquid in the cavities is relatively small. There are, of course, no male flowers to produce pollen-grains, and the female flowers which everywhere cover the walls give origin to young seeds in place of young insects ; but there is a general hypertrophy of the tissues of the fruit and great growth in the ovaries.

The hypertrophy is not, however, so great as in the case of the other kind of fruits; in this case the maturer receptacles rarely have diameters exceeding two and a half inches, whilst in many gall-fruits (Plate V.) they often reach three and three-quarter inches, or even more.

In the neighbourhood of Calcutta the fruits of *Ficus Roxburghii* are visited by only one kind of fig-insect, which seems to be a species of *Eupristes*. It is probable, however, that this is really related to one or other of the commoner figs native to that part of Lower Bengal, and has only learned by the experience of late years to appreciate the advantages provided by the large size and succulent quality of the fruits. That this is the case seems to be indicated by the fact that, though the trees in Calcutta do not bear continuously over-lapping crops of fruit, but are practically barren for a prolonged period every year, the crops which are produced are regularly attacked by insects. Moreover, in the Sikkim Himalaya, from which all the trees in Calcutta were originally derived, the insects which utilise the fruits are of an entirely distinct kind, and in specimens obtained from the neighbourhood of Cherat, in the far north-western hills, a third species of insect was present. But in any case there can be no question that were there no figs there could be no fig-insects, and that in the absence of insects the production of mature pollen and fertile seeds would be an entirely exceptional event in figs; in the absence of fruits providing suitable accommodation for their ova



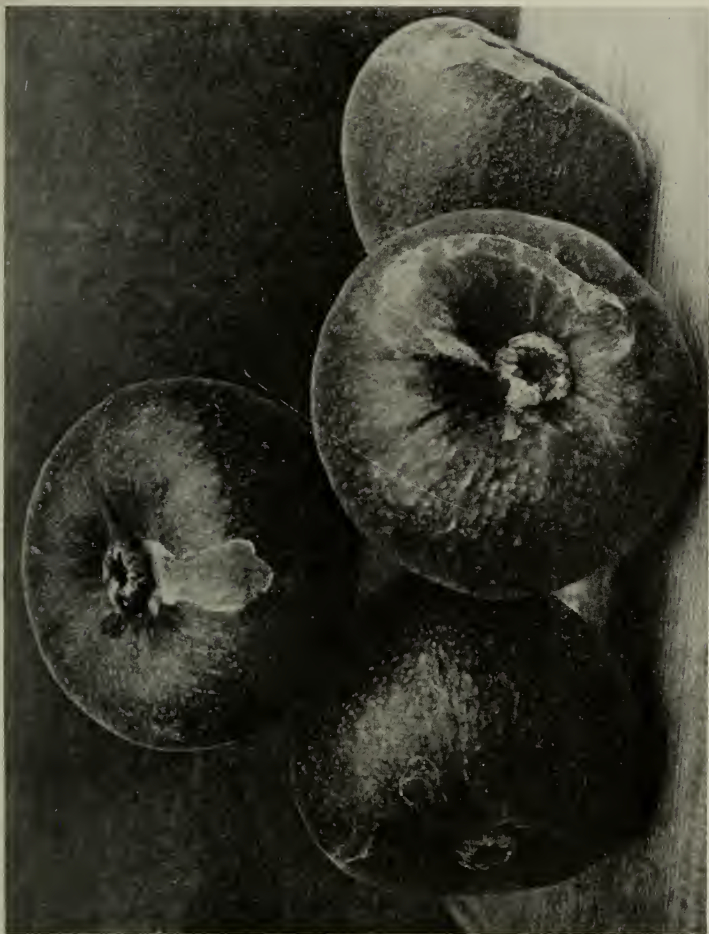


PLATE V.—*Ficus Roxburghii*: GALLED FRUITS.





and young the insects would necessarily die out ; and in the absence of the insects the young fruits would be deprived of the stimulus securing the nutritive supply necessary to occasion the maturation of the stamens and the development of embryos within the ovaries of the normal female flowers.

Where the fruits of any species of fig have acquired the characters of those of *Ficus Roxburghii* ; when the receptacles containing embryonic male and true female flowers are not only distinct, but borne on different trees, the development of fertile seeds would, apart from the intervention of some special external agent, necessarily be confined to exceptional cases in which pollen matured within a male fruit was accidentally transferred to a female one in the teeth of almost insuperable obstacles, or in which accidental processes of parthenogenesis took place within individual female flowers. In either case the production of fertile seed would necessarily be an exceptional event, whereas under the influence of insects it occurs constantly and profusely.

There can be no question that the intervention of the insects is absolutely necessary to ensure the production of seeds in sufficient numbers to provide for the continued existence of the kinds of trees which they frequent, but it remains to be ascertained what the exact nature of the fertilising process is, and this can only be done by means of special study of the life-history of the insects and of the precise conditions under which they gain access to the interior of the fruits. In dealing

with the subject, and taking *Ficus Roxburghii* as an example, the best starting-point seems to be afforded by an examination of the conditions which are present in any mature male fruit (Plate VI.) in which the insects contained within the modified female flowers are about to emerge from their cradles. The fact that the process of ripening has reached this stage may be readily recognised from without, for the fruit, which has previously been extremely firm owing to the extent to which it was gorged with liquid, now readily yields under pressure, and its outer surface at the same time gradually loses its original greenish tint and becomes reddish yellow. When a fruit in this state is laid open, the band of male flowers surrounding the bracts which plug the orifice stands out conspicuously, owing to the presence of a crowd of filaments bearing anthers full of pollen-grains of minute size. The rest of the cavity is lined by several layers of the enlarged ovaries of gall-flowers containing insects, and is stained of a deep madder-brown by pigment macerated out of the tissues of the flowers when the central space was full of fluid, and deposited as a sediment when it dried up. The potential canal leading from the outer surface of the fruit into the central cavity is closed by a solid plug of overlapping scales about half an inch in thickness and so firmly resistant that, even at times when the fluid in the cavity is under such pressure as to escape in a jet at any artificial puncture, it never allows of any appreciable exudation.

A mature fruit only retains such characters for a

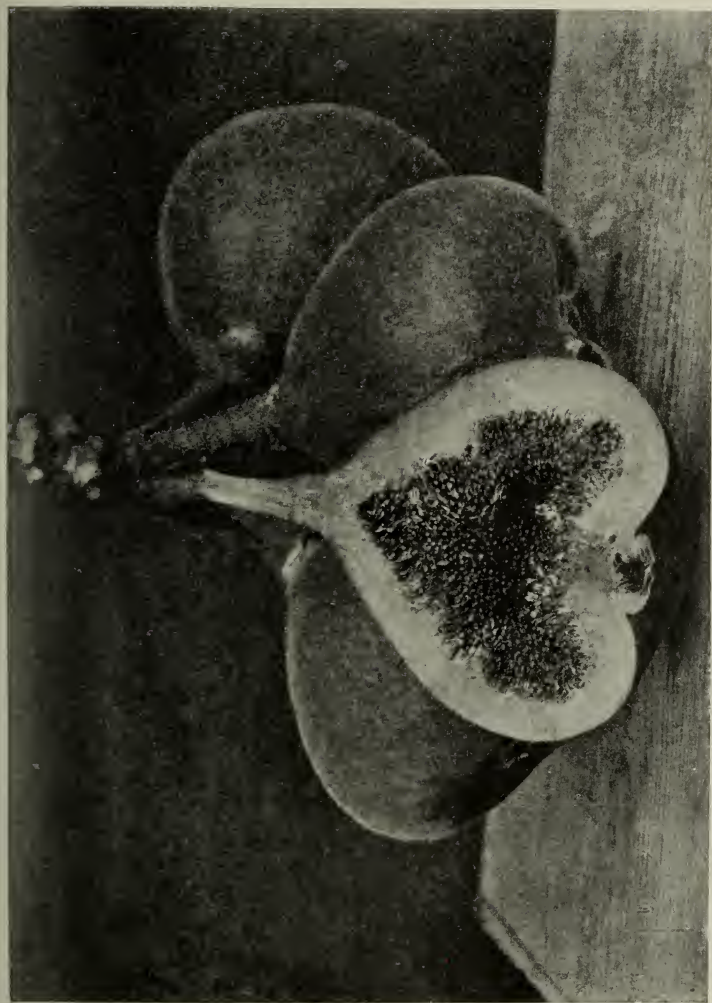


PLATE VI.—*Ficus Roxburghii*: A GALLED FRUIT LAID OPEN.





short time, for in normal specimens the male insects of the colony very soon begin to break out of the flowers containing them by gnawing through the walls of the ovaries with their strong jaws. For a time they alone escape, and wander about the cavity, perforating the walls of the ovaries containing female insects, assisting their inmates to emerge and often entering into connubial relations with them before they have completed their escape. The male insects are truly ungainly objects, of a pale amber-colour, wingless, and with telescopic abdomens and powerful cutting jaws. As time goes on and more and more of them escape, they gradually travel convergently to that part of the cavity where the plug of bracts is situated, and in doing so force their way through the band of stamens, gnawing up the filaments and anthers into a mass of *débris* mixed with a dust of pollen-grains.

Up to this point the insects have only had to deal with relatively feeble obstacles, but they now find their progress opposed by a really formidable one; for, in order to reach the outer surface of the fruit, they must tunnel their way through the walls of the cavity, or through the hardly less solid mass of bracts plugging its orifice. As a rule they prefer the second track, and soon settle down to bore a cylindrical passage straight through the substance of the plug. For a time the growing tunnel is stuffed by the bodies of struggling workers and the *débris* which results from their labours, but the task is pursued with such energy that a passage is soon forced and an opening

appears on the outer surface of the fruit and vomits forth a stream of blundering creatures, who either fall immediately into the hands of the swarms of predatory ants who are lying in wait for them, or, after wandering vaguely and helplessly about for a season, drop to the ground and quickly perish either by a natural death or as the victims of various sorts of enemies. They are of no more use to the community after they have married and secured the escape of the females, and with this they die out. In most cases winged females begin to make their exit from the tunnel very soon after it has been finished. At first they appear in small numbers and in the company of their awkward husbands, but presently more and more begin to hasten out, and for some time after all the males have disappeared they continue to pour out and form a little cloud over the fruit as they rise in the air.

Such is the order of events in cases in which the two sexes of the insects within a fruit are present in normal proportions to one another, or, in other words, when there are enough males to assist the females to escape from their cradles, to marry them, and then to provide them with a path of exit from the cavity of the receptacle. But all fruits are not alike in this respect; in some cases the number of males is so small that emergence is delayed and imperfectly carried out; and in others females alone are present, and, as they are not provided with jaws equal to the task of perforating the walls of their prisons, remain permanently enclosed and perish miserably. When one

of these imperforate fruits is laid open before the death of its inmates, a curious spectacle reveals itself, for the lower part of the cavity is occupied by a black mass of struggling insects, who at once begin to steam up in clouds into the surrounding air.

When female insects have made their way out by the normal route they sometimes fly off at once, but usually they loiter about for some time, drying and stretching their wings, and clearing themselves of particles acquired during their journey along the course of the narrow tunnel. This *débris* is always small in amount, and is for the most part composed of dust from the perforated tissues of the bracts and stamens. It must, of course, often include a certain number of grains of pollen, but these are never present in sufficient quantity to attract attention even when the eye is aided by a simple lens. Very many of the insects have barely time to struggle out before they are seized by the eager ants who hurry about over the surface and peer into the orifices of the caverns furnishing such rich stores of prey. Those who escape capture presently fly off, and, where many large fruits are simultaneously discharging their freights, a fine mist of hovering insects fills all the air around ; for most of the emigrants linger for a time near their birthplaces before dispersing in quest of suitable quarters for the reception of their eggs. In many instances no fig-trees providing these are present in the immediate neighbourhood, and under such conditions all signs of the recent emergence of a swarm presently disappear. Wherever a tree



bearing fruits in a proper state of development is to be found, the flying insects at once settle down to energetic attempts to penetrate to the interior of the receptacles, but before they can do so they are often obliged to travel over considerable distances—in the Botanic Gardens in Calcutta they were frequently fain to travel for at least half a mile in order to meet with a suitable tree.

When they do come across one, they very clearly show that they can distinguish the fruits which are in a fit stage of evolution from those which have not yet reached or have passed beyond it. Again and again they approach individual receptacles, and after carefully examining their orifices, retire and set out in quest of others more adapted to their purposes. The peculiarities which guide them in their choice seem to lie in the bracts of the ostioles, for it is only after a careful examination of them that a decision is arrived at. Whatever the determinant features may be they must be common to both kinds of fruits, for insects struggle just as vigorously to gain access to the interior of true female figs, within which it is impossible for them to find quarters for their eggs, as they do on meeting with fruits full of flowers specially modified into nurseries.

Whenever a suitable fruit of either kind has been found, the arduous task of forcing an entrance into it is undertaken. The obstacle which has to be overcome consists, as has already been pointed out, of a dense and practically solid plug of stiff, adhesive, overlapping scales, about half an inch in thickness. The invaders have no weapons, like

the strong jaws of the males, capable of boring a passage through the obstruction, and are therefore obliged to force their way inwards as well as they may between the glutinous surfaces of many successive tiers of bracts. They throw themselves furiously against the bulwark and by dint of energetic and continued efforts gradually force their way into its substance. Only a very few of them, however, succeed in reaching the cavity of the fruit, and by far the greater number perish miserably *en route* and remain to form thin black layers sandwiched between the tiers of bracts. In the course of this struggle they very soon lose their now useless and obstructive wings, so that those who are lucky enough to reach their destination do so looking very much like small brown ants. The numbers who do succeed in forcing a passage vary greatly in different instances, but as a rule more successes take place in fruits containing male and gall-flowers than in those in which true female ones alone are present. This is doubtless owing to the fact that the plug of bracts in true female fruits is both thicker and somewhat denser than that in the other kind of receptacles. In the case of fruits containing male and gall-flowers, as many as twenty or thirty insect corpses may often be found within the cavity, but in that of true female ones it is very rare to find more than four or five, even in instances in which an enlargement of the ovaries and the initial evolution of young seeds have set in all over the surfaces of the walls. The number of ovaries showing signs of the evolution of seeds bears no direct ratio to

that of insect corpses, and in many cases in which there is no evidence to show that more than a single insect gained access to the cavity of the fruit, signs of ovarian hypertrophy are everywhere present. In one such instance more than eleven thousand seeds ripened and yielded an enormous crop of seedlings.

As soon as an insect reaches the cavity of a fruit of either kind, she forthwith sets about attempting to lay her eggs within the ovaries of the female flowers which it contains. In the case of fruits containing male and gall-flowers, she has little difficulty in effecting her purpose owing to the thinness and delicacy of the tissues intervening between the surfaces of the ovaries and the sites in which she wishes to deposit her eggs. But this is not the case in fruits containing normal female flowers, for in these the walls of the ovaries are so thick and resistant as to prevent the ovipositor from penetrating to the desired depth, and the unhappy insects wear themselves out in futile attempts to get rid of their burdens, hurrying round and vainly stinging flower after flower until exhaustion and death put an end to their efforts. But, though such attempts are entirely futile in so far as the end to which they are directed is concerned, they are of immense importance in the economy of the fruit which is attacked ; for, were it not for the stimulant action of the stings and its effect in giving rise to widely diffused nutritive reactions throughout the tissues of the tree, the evolution of any perfect, fertile seeds could only occur as an entirely exceptional event.

The stimulus supplied by the access of insects to fruits containing only male and modified female flowers leads to the maturation of the stamens with production of ripe pollen, to the development of young insects within the ovaries of the female flowers, and to great general hypertrophy of the tissues and exudation of fluid into the cavity of the receptacle. In fruits occupied by normal female flowers the same stimulus is followed by general hypertrophy and the development of fertile seeds. In both cases a great increase takes place in the nutritive supply of the fruits; their stalks become much thicker, their receptacles enlarge in every dimension, and such a strong tide of liquid is directed towards them that, in the case of those containing male and gall-flowers, the overflow which fills the cavities is in a state of such high pressure as to escape in jets from any punctures of the surrounding walls.

The most interesting question which presents itself in connection with these phenomena concerns the precise causation of the changes taking place in the female flowers, and leading to the formation of fertile seeds within them. There can be no doubt that the access of insects is as essential to the production of mature pollen by the male flowers of one kind of fruit, as it is to the formation of perfect seeds by the female flowers of the other, but this does not necessarily imply that both of the events are precisely parallel. Every one will be disposed to ascribe the maturation of the stamens to the increased nutritive supply attending the access of the insects, but it is not at first sight clear that the



evolution of the seeds should be ascribed to the same origin, or ought not rather to be regarded as the outcome of ordinary processes of pollination effected by the agency of insects.

The access of insects is certainly necessary to the development of fertile seeds in the interior of the fruits containing normal female flowers, but it remains to be determined how the two events are related to one another; it has to be ascertained whether the mere access of the insects and its attendant stimulation of nutrition is the essential factor, or whether the latter does not lie in the introduction of pollen by the invaders. It is, of course, well known that in very many cases the access of insects to flowers is essential to the development of seeds because it is the means by which pollen is applied to stigmas at the time at which they are ready to respond to it, and at first sight it may seem as though in the present case we are merely dealing with an additional and striking example of this common event. But the more closely the conditions actually existing in it are examined, the more difficult does it become to retain such a belief.

The insects have to encounter such formidable obstacles in forcing their way into the fruits containing female flowers that it is almost impossible for them to succeed in carrying in any extraneous materials. It has already been pointed out that the plug of bracts closing the orifice of the fruit is so resistant and so adhesive from the presence of glutinous secretions, that not only do the insects very soon lose their wings in attempting to force

a passage through it, but that only a very small percentage of them ever attain their object, whilst the most perish *en route* and remain entombed in the labyrinth of scales. Even did all the insects who attempt to enter succeed in doing so, it would be hardly possible for them to carry much pollen with them ; and, as the number of them who do get in is invariably very small, it is clear that the pollen which they may possibly carry in must be of such small amount as only to suffice for the normal fertilisation of a few stigmata, whilst in most mature fruits many thousands of fertile seeds are produced. Moreover, as has already been pointed out, it is quite impossible to detect the presence of any definite numerical relation between the number of insects entering a fruit and that of the seeds developed in it. In instances in which there is no evidence that more than a single insect succeeded in forcing entrance the number of seeds is often so great that, in order to account for their production as the result of ordinary processes of pollination, it would be necessary to assume that the insect entered the cavity of the fruit entirely covered by a layer of pollen-grains, or, in other words, in a condition which in the circumstances attending ingress is absolutely impossible. It is conceivable that a few pollen-grains may be stowed away in such sheltered nooks in the body of an insect as to adhere until their porter has struggled into the cavity of the fruit, but it is quite impossible that any insect should arrive there completely clothed in pollen after having had to force her way through "all the devious mazes that

she ran " in traversing the tissues of the ostiolar plug.

The development of the vast majority of the seeds in *Ficus Roxburghii* is, therefore, quite clearly not the outcome of any ordinary processes of pollination, but must be accounted for otherwise, and in any attempt to do so only two hypotheses seem to merit serious consideration. It is certain that the agency of insects is normally essential to the development of seeds within the fruits containing true female flowers, and it is practically certain that it cannot act by determining the occurrence of ordinary processes of pollination; consequently, the only conclusions remaining are, either that the result is not in any way dependent on pollination, or that the latter is carried out in some exceptional way. The problem would at once be solved could it be shown that the pollen-grains were endowed with exceptional properties by means of which they were capable of giving origin to tubes which, in place of remaining simple, underwent indefinite ramifications so as to form large numbers of ultimate twigs, each able to enter into fertilising relations with the stigma of an individual female flower. But there is no experimental evidence to support this hypothesis. Careful examination of the contents of female fruits which have been recently entered by insects fails to reveal any signs of the presence of any branching pollen-tubes; and pollen-grains, when sown in suitable nutritive fluids, although they germinate freely, never produce tubes showing any inclination to branch. But, if it be impossible

that more than a few grains can ever be introduced, and if there be no evidence to show that those which do enter possess any exceptional properties serving to render them capable of fertilising an indefinite number of stigmas, how is the constant production of enormous numbers of seeds to be accounted for? In any attempt to answer this question it is necessary in the first place once again to call to mind the effects following the access of insects to fruits of either kind ready to play the part of hosts. In the case of normal female fruits the invasion is followed by the development of large numbers of seeds, and in that of fruits containing male and gall-flowers by the maturation of stamens and the evolution of hosts of young insects. But these are not the only effects which are produced, for in both cases alike a certain quantity of pollen may be introduced, and in both an excessive indraught of nutritive supply takes place and occasions hypertrophy of the tissues of the individual flowers and of the receptacles from which these arise. The access of the insects gives rise to general hypertrophy of the fruit, to maturation of male flowers, to the development of young insects within the ovaries of gall-flowers, and to the formation of fertile seeds by normal female flowers; and it is as essential to the full evolution of pollen-grains as it is to the development of seeds.

Now no one will be disposed to ascribe the changes taking place in the stamens of the immature male flowers to any specific fertilising action exerted



by the small number of pollen-grains which may have been introduced by the intrusive insects, and, as has already been shown, the amount of pollen which can possibly enter female fruits is evidently wholly inadequate to secure the occurrence of normal fertilisation in the enormous numbers of individual flowers which ultimately produce seeds. In the one case any specific action of invasive pollen is out of the question, and in the other it is clearly quite inadequate to account for the enormous production of seeds ; why, then, should we refuse to regard the results in both as of like origin and as the outcome of the special nutritive conditions established by the access of the insects ? In both cases alike invasion leads to a great increase in nutritive supply followed by general hypertrophy of all the tissues of the fruit, and by evolutionary changes in the flowers which in one instance lead to the formation of mature pollen, and in the other to that of seeds. The sequence of events in both cases follows a like course, and there seems to be good ground for believing that this parallelism is not fortuitous, but indicates the action of a single cause ; or, in other words, that the maturation of the pollen and the production of the seeds are alike the outcome of the increased nutritive supply determined by the stimulation of the tissues of the fruit which is caused by the presence of insects within it.

The effects on general nutrition which are produced by the access of insects in this and similar cases are parallels of those following pollination in other kinds of plants. In both cases alike the

application of the stimulus is followed not only by the formation of seeds, but by far-reaching changes indicating the presence of influences affecting the nutrition of the tissues over wide areas. Familiar examples illustrative of such general stimulation after pollination are presented by many of the bulbs commonly cultivated in English gardens. Should the flower of a tulip or those of a crown-imperial be fertilised, ovarian hypertrophy and the formation of seeds are not the only results of the event, but the foliage all along the course of the axes of the plants remains green and active for many weeks after that on unfertilised specimens has wholly faded and dried up. Even more striking instances, however, are present in the branched inflorescence of some orchids. If a few individual flowers be fertilised at separate points in a large head of *Renanthera coccinea*, it will be found that for a period of many months, and long after all the unfertilised blooms and the portions of the axis of inflorescence connected with them have withered and died, tracts of living tissue ascend from the stem and pass outwards along the course of all the twigs bearing enlarging ovaries and young seeds so as to maintain a vital relation between them and the permanent parts of the plant.

But in cases in which the development of seeds follows pollination, the stimulant agent not only gives rise to general effects on nutrition, but to the occurrence of specific interaction between living elements contained in it and the stimulated object ; so that before deciding that, in such exceptional

cases as that of *Ficus Roxburghii*, fertilisation is determined by general nutritive stimulation alone, it is necessary to ascertain whether the details of the process present any unwonted features. Of the fact that they actually do so there can be no question. Any elaborate statement in respect to this point would be out of place here, and it may be enough to mention that the embryonic plants are developed in exceptional sites within their parent ovaries and that they do not originate within the so-called embryo-sac, but as the outcome of processes of hypertrophy and division in the body of a peculiar cell situated in the layers of tissue surrounding that cavity. The processes of growth and division occurring in cells of this nature under the influence of the general stimulation of nutritive activity in fruits which have been invaded by insects ultimately lead to the formation of bodies which may be regarded as buds resembling those that, as every gardener knows, arise in certain conditions in the tissues of the leaves of begonias and bryophyllums. Where the occurrence of pollination is necessary to the production of fertile seed the rudiments of the young plant originate at one definite point within the body of the parent ovule, but in the case of *Ficus Roxburghii* they normally make their appearance in another and quite distinct one; and this fact strongly reinforces the other evidence showing that the process of fertilisation is here exceptional and independent of any specific influence exerted by the access of pollen.

It has already been mentioned that in the case of a few flowers in a receptacle pollination and

ordinary processes of fertilisation may take place; but most certainly such an event must be very rare, and the number of instances in which it can possibly occur are wholly insufficient to account for the enormous quantities of seeds which are constantly produced by fruits to which only one or two insects have gained access.

Such are the facts in the case of the fruits of *Ficus Roxburghii*, and it appears probable that they will be found to be present in that of those of other species of figs of like nature. It does not, however, necessarily follow that they must be present in all figs, or that they may not vary in certain details in species in which the structural characters of the fruits present considerable variations. In all those species in which, as in *Ficus Roxburghii*, the orifices of the fruits are closed by dense, thick plugs of bracts and the included cavities contain either normal female flowers alone or male and gall-flowers, it is almost certain that the evolution of seeds as the result of pollination must remain quite exceptional; but where the closure of the floral cavities is less efficiently carried out, and more especially in cases in which the individual cavities contain all three kinds of flowers, the facilities for the occurrence of pollination must be greatly increased, and with this, ordinary processes of fertilisation may become predominant. Whether they ever entirely replace the parthenogenetic ones which have just been described is a question which can only be answered by means of the close study of the fruits of many distinct species of figs. There can, however, be no doubt that in the case of some



species in which the fruits are by no means so securely plugged as those of *Ficus Roxburghii* the ovules of the female flowers contain special elements, precisely like those occurring in the walls of the ovules in that species as the origins of embryos. Moreover, there is some evidence to show that fertile seeds may occasionally be developed in the fruits of species, in which male and normal female flowers are always borne on distinct trees, under conditions implying not only the absence of trees to provide pollen, but also the absence of insects to convey it. The fruits of the commonly cultivated *Ficus carica* occasionally produce a certain number of fertile seeds in the British Islands where neither male trees nor fig-insects are to be met with. At the present time there are two young fig-trees in my garden in Torquay which were raised from seeds ripened on the spot. My attention was first attracted to the question by the spontaneous appearance of a seedling in one of the beds in the garden, and when the next crop of fruit ripened on a neighbouring tree two receptacles were reserved for experiment. They yielded an enormous number of seeds, and the outcome of sowing these is represented by the two young trees which I now have. In this case only two seeds out of many hundreds which were sown proved to be fertile, and it is probable that, in the absence of the special stimulus to nutritive activity provided by the access of insects, the number of parthenogenetically produced embryos always remains very small. An instance of this kind certainly gives no ground for the belief that the agency of insects could be

dispensed with without seriously limiting or even practically suppressing the production of fertile seeds, but it unequivocally seems to demonstrate that the fruits are endowed with a potential capacity for the production of such seeds quite apart from the occurrence of pollination or the presence of any insects to secure its occurrence. Here there were no male trees to supply either pollen or insects to convey it, and yet the production of fertile seed was not entirely suppressed. There are only two ways of accounting for the occurrence—it must either have been the outcome of parthenogenesis, or have arisen as the result of the abnormal development of a certain number of male flowers within the fruits of a female tree; but, although it has been shown that the fruits on a “caprifig,” as the male tree of *Ficus carica* is termed, may sometimes include a certain number of normal female flowers among the gall-flowers which line their cavities, there is, in so far as I know, no evidence to show that a female tree can ever bear fruits containing any male flowers.

Taking all the data into consideration—the unquestionable influence which the access of insects exerts on the maturation of both male and female flowers; the evident inadequacy of any pollination by insects to account for the great number of seeds which are constantly produced; the abnormal sites within the ovules in which the embryos appear; and the occasional development of fertile seeds in the absence of male flowers and fig-insects,—the only logical conclusion seems to be that in figs like *Ficus Roxburghii* we are dealing with

organisms in which the female flowers are endowed with a potential capacity for parthenogenesis which is called into play on a large scale under the influence of the greatly increased nutritive activity and supply excited by the access of the insects to the interior of the fruits. It almost seems as though the development of seeds in such cases were more or less parallel to that of certain malignant growths which apparently originate under the influence of special irritation in previously normal tissues. The altered conditions of nutrition induced by the access of the insects seems to enact the rôle of the modified liquid environment in Loeb's experiments on the parthenogenetic evolution of the ova of certain marine organisms. Loeb points out that the ova in his experiments appear naturally to be on the brink of undergoing parthenogenetic development, and, in the case of figs, the structural peculiarities of the ovules and the occasional production of fertile seeds in the absence of both male flowers and fig-insects would seem to indicate the presence of a like condition.

In whatever way we may choose to account for the production of seeds in such cases, the elaborate interdependence between the insects and the trees which they infest remains equally wonderful and perplexing. Without the presence of the insects the trees would soon die out, and without that of the trees the insects would suffer a like fate. The interdependence is so complete and the reciprocal relations of the two sets of organisms have now become so elaborate that it is very hard to frame any definite theory regarding the order of the

evolutionary events leading up to the existing conditions. In such cases as that of *Ficus Roxburghii* the mutual adaptations of fruits and insects have attained a marvellous elaboration; not only are the female insects provided with weapons with which to irritate and in certain cases perforate the walls of the ovules, and the males endowed with jaws of such size and strength as to enable them to assist their mates to escape from their cradles and ultimately from the interior of the fruits containing them, but in one of the two kinds of fruits the female flowers have been specially modified in such a fashion as to render them quite incapable of producing seeds but fit to receive the ova of insects and provide a suitable environment for the evolution of the young organisms originating in them. But this is not all, for the entire plants have undergone special modifications leading them to respond to the stimulus supplied by the attacks of the insects by a great rise in the nutritive activity and supply of the fruits and thus to provide the conditions necessary to secure the maturation of pollen and the development of insects in one set of receptacles and the formation of fertile seeds in the other. The question is so highly complicated by the elaboration of the reciprocal relations of the animal and vegetable organisms, that any attempts to frame a rational theory regarding the steps which must have led up to the existing conditions almost always tend to mental vertigo and a temptation to cut the Gordian knot by the adoption of Beccari's doctrine of "plasmation," or, at all events, to an inclination to regard the



phenomena as indicative of the inheritance of acquired peculiarities both in the insects and their hosts. Surely, in any country like India in which such problems abound, there need be no cause for the indifference and *ennui* which Goethe thought would be inevitable were all the secrets of nature to be revealed to us !

The fruits of fig-trees are often invaded by other kinds of insects besides those which are essentially related to their maturation. The mere presence of the latter is in itself enough to serve as a special attraction to various predaceous species. In the case of *Ficus Roxburghii* such visitors are mainly represented by two kinds of ants, *Sina rufonigra* and *Æcophylla smaragdina*. They rarely fail to be in attendance when broods of young fig-insects are emerging from the fruits, and both species are certainly able to ascertain the impending emergence of their prey at a time when there are no appreciable signs of it save a certain loss of resistance in the texture of the walls of the fruits following the absorption of the liquid which previously gorged their cavities. They seem to be greatly excited whilst awaiting the exit of their victims, and are savagely resentful of any interference with their vigil, so that, as *Æcophylla smaragdina* is by far the most abundant of the two species, it is only in cases where fruits are present in great numbers or have casually escaped notice that *Sina rufonigra* has a fair chance of sharing the spoil.

Other kinds of insects visit not merely the outer surfaces of the fruits, but settle for a long time

within the cavities of the female ones. Two of the commonest are the larvæ of a small moth and a strange little brown ant. The larvæ are purely mischievous tenants, who in no way farther the production of seeds or give rise to any special nutritive activity in the fruits, though they do cause them, in so far as outward colouring and softened texture are concerned, to simulate maturation. Their action is purely destructive and devoted to the consumption of masses of the flowers. The ants which establish themselves within the fruits belong to the genus *Pheidole*, and perforate the walls of fertilised female fruits in order to convert the included cavities with their abundant stores of saccharine substances, derived from the decomposition of the floral envelopes, into formicaries within which they may rear their young in safe and comfortable seclusion. They are better tenants than the larvæ, for, though they do nothing towards securing the development of seeds, they do not in any way interfere with its occurrence or injure the products of the process. The young ants resemble young fig-insects in being dependent on the tissues of the figs for nutrition, but no special provision has been made for their accommodation, and the maturation of the fruits providing for their nutrition is determined, not by the access of their own parents, but by the antecedent entrance of mature fig-insects. The relations existing between the young insects and the fruits are in this case very slight, but they may possibly represent the rudiments of the intimately co-ordinate ones which are present where true fig-insects

replace ants. How and at what stage in the evolution of the fruits the larvæ of moths gain access to the cavities, it is hard to say ; but, as there are never any evidences to suggest that they enter by direct perforation of the walls, it seems probable that they are the outcome of ova deposited among the ostiolar scales at a time when the tissues were so soft and yielding as to lend little resistance to any active attempts at entrance.

## CHAPTER IV

### MOSQUITOES, FLIES, AND FLEAS

As when a swarme of gnats at eventide  
Out of the Fennes of Allan doe arise.

*The Faerie Queen.*

Ces animaux sont soûls ; une troupe nouvelle  
Viendront fondre sur moi, plus âpre et plus cruelle.

LA FONTAINE.

Je hante les palais, je m'assieds à la table.

LA FONTAINE.

And the dog said nothing, but searched for fleas.

*Fly Leaves.*

NOWADAYS, when mosquitoes are regarded with such awe and taken so seriously in connection with the origin of malarial diseases, it seems almost impious to allude to them in any casual record of frivolous observations, but, at the same time, they are so abundant and so certain to attract attention in tropical regions that it is almost impossible wholly to ignore their existence in any sketch of the normal experiences of life in a place like Calcutta. Fortunately there are a few points regarding them which are of some trivial interest, quite apart from any serious pathological considerations, and open to observation without any special information or appliances. Almost every one who has lived for any length of time in a mosquito-haunted region must have had a practical and



personal demonstration of the value of the administration of repeated sublethal doses of a poison as a means of establishing artificial immunity to its action. There are certain fortunate people who seem to be in some degree naturally insusceptible to the irritant action of mosquito-bites, but, as a rule, the life of any one on first arriving in Calcutta from the British Islands is for a time rendered almost intolerable by it; and I cannot forget how, during the first few months of my residence, I could only close my hands with difficulty owing to the swelling caused by innumerable bites. But, as time goes on, the amount of irritation gradually subsides, and, after the course of years of constant exposure to their bites, mosquitoes would often be regarded with complete indifference were it not for the pungent quality of their notes. Immunity acquired in one locality does not necessarily serve to provide complete exemption in another. Whether this be owing to differences in the quality of the venom in differing species or local races, or to the fact that the insects of particular localities find a change of diet pleasant, and so are specially attentive to new-comers, I cannot say; but what I do know from painful experience is that, long after I had come to regard the mosquitoes of Calcutta with indifference, those inhabiting Jalandhar once treated me to a very lively day. After artificial immunity has been fairly established their punctures only occasion a short, sharp prick like that of a needle, and no irritation, itching, or swelling follows. The penetrating, red-hot quality of their notes when close at hand, however, remains

a permanent cause of nervous irritation. A room infested by swarms of mosquitoes is filled by deep-toned humming, but when an individual insect approaches its intended victim the note alters and acquires a truly distressing keenness. How often has one cursed the carelessness of the bearer when such shrill piping announced the fact that one or more insects were shut up within the enclosure of the curtains ; how often has one heard it coming closer and closer ; and how often has one given oneself a violent and futile box on the ear in the hope of slaying the enemy when he settled down to work. Prolonged experience teaches that in such circumstances the only efficient plan is to take up a large fold of the sheet, or whatever kind of bed-covering may be in use, over the arm, wait patiently until the tormentor is on the point of alighting, and then bring it round with a widely sweeping movement so as to counteract any attempts at sidelong flight.

Mosquitoes who have had a really heavy night within the curtains of a bed often show a curious habit which might be interpreted as indicative of considerable intelligence, but which is probably merely the outcome of a quite irrational survival of the fittest. On the morning after such a drinking bout they are usually to be found seated high up on the curtains, and in such a gorged and drowsy state that it would seem as though they might be killed with the greatest ease. But they behave as though quite aware of their danger, and, on the least disturbance, let go their hold on the net and fall straight downwards without making any

attempt at flight. The result of this is that they generally fall between the sides of the bedding and the lower part of the curtains, and are ready to take wing whenever these are displaced. They often have a strange way of gathering in thick columnar clouds over the heads of people who are sitting quietly in the open air. Such swarms do not seem to cherish any evil intentions in regard to their involuntary neighbours, and they are probably attracted by the heat and moisture rising into the air from the human body.

Common house-flies are sometimes very annoying even in countries like England in which climatic conditions forbid their continuous multiplication, but no experience of them in such circumstances can serve to give any just idea of the pest which they may become in warmer regions where they are not forced into prolonged periods of inactivity. Even in the tropics, however, it is by no means the case that they are invariably and uniformly annoying, for certain other conditions besides those of temperature exert a great influence on the degree of their prevalence in particular places. In desert regions which are only occupied by a sparse or recent human population their numbers are relatively small even where climatic conditions are most favourable to them, and it is only in densely peopled areas, and specially in those which have been long occupied by human beings, that true plagues of flies are to be met with. The dominance of this factor in the prevalence of house-flies must have been forcibly impressed on every one who has ever lingered along the course of the Nile in Egypt.

The whole track of the river is more or less haunted by flies, but there are certain points in it at which they become a veritable pest, and where a single night's halt is certain to stock a dahabia with them, however carefully it may have been cleared previously. This, naturally enough, is sure to take place whenever the boat is moored close to any town or large village, but the result is very much the same where only a few miserable hovels occupy the site of some ancient but now deserted city. Certain conditions would seem to be determined by the presence of a dense human population and to go on acting long after the original cause of their development has ceased to exist.

Striking examples of this fact are not wanting in India. Almost all Indian towns, with their packed population and innumerable open shops, are more or less fly-infested, but in certain cases there are distinct evidences to show that the extent to which they are affected is not determined solely by the characters of climate or the numbers of residents, and that duration of occupation by human beings comes into play as a very important factor in producing the result. Calcutta is a much larger town than Delhi, and, in my time at any rate, could boast of no marked superiority in respect to general sanitation; the local conditions of atmospheric temperature and humidity are certainly particularly favourable to the continuous multiplication of insects, but the town is relatively a thing of yesterday, whereas the succession of cities which have occupied the site of the present Delhi and its immediate



neighbourhood ranges back through the course of many centuries, and with this the local plagues of flies are incomparably greater than those affecting Calcutta. It must of course be allowed that in a dry region, like Delhi, flies are more apt to be annoying in their quest of the stores of moisture to be obtained from human bodies than they are in a moist environment like that of Calcutta, and that there may be a tendency to overestimate the degree of their prevalence accordingly. This, however, is a source of error which can hardly come into play in the case of a place like Almora. In it we have to deal with a very small town, situated on the top of an isolated hill in the midst of a thinly populated tract of country, but it is a very old one, and, at certain times of year, flies are quite as troublesome in it as they are in Delhi, in spite of the much lower temperature and higher humidity of the atmosphere.

To all who have ever experienced excessive persecutions from flies, any mention of them must almost necessarily seem imperfect if it do not include some notice of the best ways of preventing their occurrence, and I therefore make no apology for alluding to one or two measures for the efficacy of which I can personally vouch. The first of them is well known to most Anglo-Indians, and is specially useful in places in which flies abound more or less continually. It consists in exposing strong infusions of quassia in saucers containing fragments of bricks, and is highly efficacious in all places in which the air is dry and hot enough to make insects constantly eager

to get at a supply of water. The moist surfaces of brick form convenient landing-places from which it is easy to obtain abundant supplies of drink, which, whilst seemingly not distasteful on account of its bitterness, is endowed with highly toxic properties for flies and many other kinds of insects. Fly-traps of this nature have the great advantage of being in no way offensive in aspect and perfectly harmless to any higher animals whilst most efficiently fatal to those for which they are intended. In the case of sudden and temporary invasions, like those which have been already alluded to as often taking place in boats on the Nile, the use of quassia is again very effective, but it is always well to reinforce it by means of judicious shikar conducted by the aid of india-rubber straps. These form most effectually lethal weapons when fully extended, with one end held between the left forefinger and thumb, whilst the other is ready to be suddenly relaxed by the right hand after the victim has been carefully stalked and aimed at. A very little practice serves to secure proficiency in the sport, and it is wonderful how much amusement as well as practical benefit may be derived from it. In places where the air is excessively hot and dry, and where mosquito-curtains are in use, a subsidiary means of destruction may often be invoked with highly satisfactory results. Shortly after the curtains have been raised in the early morning the roof of the tent and the folds round its edges are generally thickly peopled by resting flies, who, if the curtains be gently dropped, remain imprisoned, to furnish a

corresponding number of dry and shrivelled corpses before the end of the day.

Blue, green, and grey bottle-flies abound in India. In many cases the extent to which they prevail in particular places is clearly regulated by the local stores of offal, but at the same time it is not at all rare to meet with instances in which the highly developed sense of smell with which they have been endowed leads flies quite astray. Any specimens of the various species of stink-horn fungi which occasionally appear in Indian gardens are almost certain to be surrounded by buzzing swarms of them. There is one of these fungi in which a spongy stem of warm orange tint bears a head of dull grey dripping pulp of such overpoweringly foul odour as to be specially alluring; and the strength of will called for in order to complete a careful drawing of a specimen, amid the distractive horrors of swarms of noisy flies and the nausea and headache caused by the polluted atmosphere, reaches heroic proportions. The flies in such cases certainly fail in finding suitable sites in which to lay their eggs, but their labours are probably not entirely thrown away, as they doubtless aid in diffusing the spores of the fungi. Various kinds of shrubs and trees also prove very alluring when loaded with evil-smelling bloom. Among the most attractive is a species of *Kigelia*, which, with a wonderful sense of congruity, produces flowers smelling exactly like raw beef, and fruits which are first-class imitations of Bologna sausages. The long pendant spikes of purple and ochreous flowers are almost always haunted by

troops of flies, but they do not seem to be quite so fetching as the radiant blooms of *Careya arborea*, which for many weeks cover the parent trees every night in a mantle of pink and white, that is thrown off each successive morning when the sun rises in his strength, and descends to spread a softly tinted carpet over the ground and to fill the air with the smell of a butcher's shop. Almost any odour which is thoroughly repulsive to human beings would seem to be attractive to flies, and hence the flowers of many kinds of Sterculias are regarded with special favour. It is not always easy to understand why certain smells should prove so alluring. There are some shrubs which bear profuse crops of inconspicuous green flowers of a pungently acid odour, and yet whilst in bloom they are quite as much frequented as trees of *Kigelia*, *Careya*, or the most offensive Sterculias. In cases of this nature it seems probable that the source of attraction lies, not in any deceptive advertisement of suitable accommodation for eggs, but in an honest invitation to partake of stores of desirable food such as those which butterflies often find in the flowers of trees and shrubs on which their larvæ certainly do not feed. Whatever the nature of the attraction may be, there can be no doubt that it must efficiently make for the occurrence of cross-fertilisation of the flowers in which it resides.

Lower Bengal is happily almost entirely exempt from certain minute and malignant flies which often render life in other parts of India almost unbearable during the times of year and in the special localities



in which they abound. The hosts of "sand-" and "eye-flies" which, quite apart from the injuries attending their bites, so efficiently maintain a state of continuous irritation by hovering about the faces of their victims in other parts of the country, are never to be met with in the neighbourhood of Calcutta; and the "pipsas" and "mohras" of so many hill stations are also unknown. At rare intervals during the course of the summer months a certain amount of worry may be caused by the presence of minute black specks pertinaciously hovering close before the eyes; but they do not seem to have any desire to settle or to mean business in the way of biting, and their attentions are apparently merely owing to the attractions presented by the relative excess of atmospheric humidity present in the immediate neighbourhood of continuously evaporating surfaces such as those of the conjunctivæ. Far different is the behaviour of the pipsas of the Eastern Himalaya, for they, in spite of their small size, form one of the most serious objections to camp life at certain times of the year within areas in which they abound. I have camped in many unpleasant places in which mosquitoes, leeches, and ticks prevailed, but for sheer discomfort I am prepared to give the palm to a dense secondary jungle full of pipsas. They are stoutly built, ochreous flies of very small size, and are fairly quiescent during the greater part of the day, but in the evening they sally forth in myriads to render the course of the next few hours truly hideous. They settle gently down on every exposed surface of skin and at once set about biting, inflicting

punctures of peculiar malignancy, each of them being marked by a minute dark speck of extravasated blood and an intolerably itching tumour. The bites of leeches are irritating enough, but, when carefully let alone, comparatively soon cease to be the source of active annoyance ; but those of pipsas, however tenderly treated, remain for many days a cause of continuous discomfort, and invariably leave persistent traces of their malignancy in the form of minute pits owing to enduring losses of substance in the injured tissues. Almost every kind of curtains provides a harbour of refuge from mosquitoes, and the attacks of ticks and leeches are comparatively easily warded off, but in a pipsa-haunted jungle the unhappy traveller can only escape by means of precipitate retirement to an enclosure of curtains of such close texture as to threaten suffocation, especially when atmospheric temperature and humidity are relatively high. Even mosquito-curtains of net deprive the air of much of its freshness, but this interference with ventilation is nothing to that attending the use of screens whose texture is close enough to render them impenetrable to pipsas ; and to be forced to use them when the air is rendered stagnant by a close environment of jungle, and is at the same time loaded with moisture which is quickly precipitated during the cooler hours of the night, is indeed a severe trial.

In the Kumaon Hills and other parts of the Western Himalaya, these little yellow fiends are replaced by mohras, flies of an allied species and like habits, but of such dark tints as to appear

almost black. Like leeches, however, they never seem to abound in these hills to the same insufferable extent as their relatives do in the damper eastern ranges, and I never had any seriously unpleasant encounters with them. A very brief experience of pipsas is almost enough to give rise to a permanent hatred of all small flies; but it must be allowed that there are certain kinds of them who are wholly innocuous and wonderfully attractive. One such species is common in gardens in Calcutta, where it often appears in small flocks which go on persistently rising and falling through the air over lawns, shining out as they catch the sunlight like little clouds of silver dust.

Among the most offensive of flies are the various kinds of so-called "forest-flies," and individuals of one species at least of these are occasional and unwelcome visitors in houses in Calcutta. Fortunately they have no taste for the human subject, but they often drive dogs wild by the persistent way in which they settle on and cling to their hair. They certainly are unpleasantly clammy to touch, and this, combined with the great tenacity with which they hold on by means of their strong, hooked claws, probably accounts for the holy horror with which dogs regard them. The behaviour of their victims is so peculiar as to advertise their presence in a room at once, even when it would otherwise have escaped notice. Whenever one of them is in a room, any dogs who may happen to be there almost at once begin to show signs of the utmost anxiety, and are every now and then to be seen starting up and rushing wildly about in search of

some place of refuge from the annoyance ; their behaviour, indeed, under such conditions is so strange as to be almost alarming to any one who does not recognise the cause of it and come to the rescue.

There are certainly many kinds of insects who are sure of a welcome, or at least of indulgent toleration when they elect to visit their human neighbours, but there are others whose intimacy is always offensive, and, among these, fleas are conspicuous. Even in temperate regions they are often troublesome enough, but, with any ordinary care, their numbers may easily be kept within narrow bounds, and houses are never subject to wholesale and sudden invasions as they are in the tropics. In most parts of India human fleas do not abound to any grievous extent, and it is usually in the course of Himalayan travel, and in consequence of having personal luggage carried by coolies, that any Anglo-Indian has any seriously unpleasant experience of their prowess. The highland race, however, is not only extremely energetic and of Brobdignagian proportions, but apparently finds a change of diet so toothsome that any one who has had the pleasure of being introduced to it is hardly likely to forget its endowments. In the plains, European houses are generally wonderfully exempt, but their immediate environment contains such countless swarms of species who normally browse on the bodies of certain of the lower animals that, at particular times of year, they are liable to suffer from temporary but inordinate invasions by intruders who do not desire to establish permanent



colonies, but who are, for the time being, sources of almost intolerable annoyance.

The attempt to keep dogs free of fleas is, at any time of year in India, a Sisyphean task. No matter how scrupulously a dog's toilette be attended to every morning—no matter how complete a clearance may seem to have been effected by lavish expenditure of soap and carbolic acid—a very brief excursion into the garden is enough to ensure the provision of a fresh host. The grass, especially during the course of the hot weather, actually swarms with fleas, and a dog has only to run about in it for a few minutes in order to be fully populated by them. It is the fact that grass forms the normal environment in which the eggs of various kinds of fleas are deposited and hatched that affords an explanation of the occurrence of temporary plagues of such insects, even in the best-ordered houses, under certain conditions and particularly at certain times of year. In order to the almost inevitable occurrence of the affliction it is only necessary to have the floor of a room freshly covered with grass-matting in autumn and let it remain without any special treatment until the following spring. For some time no warnings of impending ill appear; for whilst the temperature remains low the number of mature insects is small, and the eggs adhering to the grass of the matting lie dormant. But when spring and growing heat set in, the process of hatching takes place on a large scale, and presently results in the production of a perfect Egyptian plague of young fleas. Fortunately their bites are relatively in-

nocuous, mere pin-pricks followed by the appearance of small red spots, but the discomfort attending constant contact with myriads of small crawling and leaping creatures is enough to render life an irritant burden.

Whilst a room is fully infested, it is only necessary to walk across the floor in order to be sprinkled waist-high with innumerable agile black specks; and hardly can a foot be put out of bed in the morning before it is tingling with punctures, and decorated by an eruption of bright red points. I well remember one of my first experiences of such visitations when consulting some books in the rooms of a friend who had written to me from the other side of India for some information to be obtained in his library. The rooms had been shut up for some weeks, and when I entered them were tenanted by an army of fleas of such dimensions that nothing save the exercise of devoted heroism could have enabled me to accomplish my task. The only thing to be done was to form an entrenchment of MacDougal's carbolic powder around and beneath a table and make hasty excursions from it to the bookshelves, secure one or two of the necessary volumes, and hurry back again to the fastness. After each excursion I returned to the table besprinkled from heel to head, and although it was possible to brush off a large number of the enemies on reaching the coign of vantage, enough of them always remained to render the completion of the work a great relief.

Luckily such a state of things never lasts long, as the visitors have no desire to become permanent

inmates of houses and very soon make their way out into the open ; so that where only one room is infested and can be spared, it is only necessary to avoid entering it for a few days. In other cases, however, it becomes desirable to undertake active measures to suppress the plague. The old native plan of campaign was to strew the floor thickly with leaves of the Nīm-tree, *Melia Azadirachta*, which are so generally useful in conflicts with noxious insects ; but a much more rapidly effective treatment lies in sprinkling the floors with weak solutions of corrosive sublimate, which, when freely applied by means of a garden-syringe, quickly penetrate all the finest interspaces of the matting. In tropical regions corrosive sublimate is a very gift of the gods whenever insect or fungal enemies abound. Books, which it is almost impossible to preserve by other means, are at once rendered invulnerable by its aid, and may be safely exposed in sites where moulds, cockroaches, fish-insects, or even book-worms abound ; botanical specimens are thoroughly protected by it from almost any enemies, animal or vegetable ; Persian rugs and other precious fabrics are by its help converted from sources of ever-present anxiety into objects of tranquil enjoyment ; but there are few occasions on which it excites keener gratitude than when it serves as a means of rapidly abolishing a plague of fleas !

## CHAPTER V

### BUTTERFLIES AND MOTHS

For the prize were great butterflies fighting,  
Some five for one cup.

BROWNING.

To any one who has for years been used to a tropical environment the relative dearth of butterflies in English gardens must almost inevitably be matter of unpleasant surprise.<sup>1</sup> Now and then in specially favoured seasons there may be a few days during which flower-beds are glorified by troops of peacock-butterflies or red admirals, but, as a rule, butterflies of any kind are relatively scarce, and those which occur in greater numbers are of small size and quiet colouring. It is very different in any Bengal garden, where, unless during brief periods of excessive heat and drought, or of violent rainfall, the air is constantly full of great, brilliant creatures, wandering round in seeming idle wantonness or gathering in throngs over the surfaces of trees and shrubs whose blossoms provide stores of alluring nectar. It is perhaps during the lucid intervals of "clear shining after rain" which occur between heavy drenching

<sup>1</sup> Horresco referens! for I feel sure that my dear friend Eden Phillpotts will lose all faith in me as a gardener if he ever read this.



showers in the monsoon that butterflies are to be seen at their best. Then hosts of them come out to flap lazily about or hurry after one another in giddy mazes of flight, whilst after sunset parti-coloured moths wander through the gloom or foolishly enter lighted rooms to commit suicide at the lamps.

In such a moist region as Lower Bengal butterflies are very liable to be inconveniently burdened by adherent damp during the course of the night, and this is of course specially the case in the winter months, when the great range of temperature and the excessive clearness of the sky favour the occurrence of very heavy dews. At this time of year an early visit to a garden is sure to be attended by the sight of numbers of butterflies sitting patiently about among the shrubs and long grass, anxiously awaiting the arrival of the sunshine to dry and free their soaked and adherent wings, and so helpless that they may be picked up like leaves or flowers. The same thing takes place even more conspicuously in the hills on fine mornings during the rainy season, when the excess of atmospheric humidity and the great nocturnal fall in temperature provide for the occurrence of dews still more abundant than those of the plains. Even in the plains, however, the dewfall is often great enough not only to incommode butterflies, but to render such powerful and energetic creatures as dragon-flies temporarily helpless in spite of the relatively small surface and the stiff texture of their wings.

One of the most notable peculiarities of butterflies

in the hills is the strange difference in respect to shyness or familiarity shown by species inhabiting different localities. In the early part of autumn the lower parts of all the outer valleys in Sikkim are very hot, and at the same time they are haunted by hosts of butterflies of almost alarming tameness, who allow themselves to be freely handled and are always ready to settle on the persons of human beings as though they were inanimate objects. A striking example of this uncanny familiarity was present in October 1889 in the bed of the Tista, just where the river is crossed by the cane-bridge at about two marches from Tumlong. At that time all the great boulders on either side of the torrent were alive with large butterflies, who hardly troubled themselves to move when touched, and who, when taken up, seemed to find the surfaces of human hands quite as congenial resting-places as the rocks. In this case the peculiarity was all the more marked owing to the excessive steepness of the hills on either side of the stream and the corresponding rapidity with which it was possible to reach relatively cool and breezy heights where the butterflies showed no unwonted boldness. The remarkable departure from usual habit shown in this and similar cases may be plausibly accounted for as the outcome of certain definite peculiarities in the places in which it occurs. In such heated localities as the bottoms of low-lying, narrow valleys are when exposed to continuous sub-tropical sunshine, any source of water-supply must almost inevitably be attractive to insects like butterflies,

whose bodies present large surfaces for evaporative loss of fluid from the tissues. There is often very clear evidence of this in the case of valleys whose beds contain no permanent streams, but receive sufficient drainage during periods of frequent and copious rain to provide temporary torrents, or at all events local pools, which are enough to keep the soil in their immediate neighbourhood damp long after all the surrounding surfaces have been completely dried up by persistent strong sunshine. During the height of the rainy season in the Eastern Himalaya almost every hollow contains either running water or a series of local pools of varying size; but on the onset of dry weather in autumn these bodies of water in many cases wholly vanish and all the surrounding slopes rapidly dry up. For a time, however, the soil within the areas previously occupied by water retains a considerable quantity of moisture, and, so long as it does so, is usually haunted by throngs of butterflies. Any one who has travelled through hill-forests at such times of year must be familiar with the startling impression attending sudden emergence from the depths of the lifeless green shade of the high woods into the bright light of a narrow glade, blazing in sunshine and alive with the wings of countless butterflies spread out like a parti-coloured carpet over the lower parts of the open space where the moist soil affords a supply of water eagerly pumped up by innumerable greedy tongues. In cases like this there is hardly room to doubt that the presence of an attainable supply of water serves to determine the assemblage of

the insects, and, although there is certainly always a conspicuous torrent in the valley of the Tista, it is probable that the abundance and unwonted tameness of the butterflies there are of like origin ; because, while there is never any dearth of water in the bed of a raving mountain river, the supply is not of a nature readily to meet the wants of insects.

In the beds of snow-fed torrents there are hardly any still backwaters, quiet shallows, or exposed sandbanks, and the only permanent supply of water which insects can obtain, unless at the risk of their lives, is furnished by the spray which is dashed up and falls on the surfaces of projecting boulders. But, as all the rocks in valleys like that of the Tista very quickly become greatly heated when exposed to continuous sunshine, evaporation goes on at a pace which prevents the accumulation of any enduring damp, and hence, not only are the stones constantly visited by thirsty guests, but the latter find the supply so insufficient that numbers of them are always glad to avail themselves of any accessory stores of moisture such as those provided by the skins of human beings and other animals. The unwonted tameness of butterflies in such circumstances is parallel to that of flies in desert regions. The fact that Egypt is everywhere full of centres of very ancient and dense population is doubtless enough to explain why flies should abound so greatly throughout the country, but there is little cause to doubt that the constancy and persistence of their attempts to settle on the human body are the outcome of an imperative



need for fluid under exposure to an extremely dry atmosphere.

It is not only under such conditions that butterflies are to be found in great assemblies, but where these have been attracted independently of any absolutely needful supply like that of water, which can be derived from the bodies of human beings, the individual insects show no unwonted tameness. One of the most notable instances of a localised assembly of butterflies that I can remember to have seen in India was present on parts of the line of railway between Madras and Bombay in the middle of June 1877, just after the occurrence of the first showers of the monsoon in an area in the Dekkan, which had for a long time been practically converted into a desert by the prolonged drought of the great famine years of the southern part of the peninsula. The embankments on either side of the track were clothed in scrubby growths of acacia, and for some miles these were literally alive with countless multitudes of white butterflies. The conditions which had prevailed for many months previously had been such as to forbid the presence of any appreciable numbers of mature insects, and the sudden and local appearance of such large numbers of them must have been the result of the stimulation of multitudes of chrysalids which had been lying dormant during the drought, and were roused into activity by the advent of moisture.

Many trees and shrubs on coming into flower form centres of attraction to throngs of butterflies. *Erythrinas*, *Ixoras*, *Durantas*, and *Saracas* seem to

be particularly attractive. When the common *Ixoras*, which abound in every garden in Calcutta, begin to clothe themselves in tufts of scarlet blooms they are almost always visited by great fluttering robbers, whose wings are brave in the brightest cobalt-blue and velvety black. During the early part of the rainy season large numbers of wonderfully beautiful creatures haunt the jungles of rank grass which rapidly shoot up in all the moist hollows. They are not specially brilliant, but are particularly alluring from the pearly grey tints of the general surface of the wings in contrast to a marginal row of splendid orange ocelli. The hollows which they frequent are often perfect menageries at times when everything around is dry and lifeless. Monstrous striped leeches, great crickets and grasshoppers, and many species of butterflies and moths find a congenial shelter in the tangled vegetation. Among the commonest moths are big ones who start up suddenly before any one who intrudes on their seclusion, dart wildly about as vagrant patches of orange and ochre, and then suddenly disappear among the crowding culms of long grass and yellowing sedge. So closely do their colours and the patterns on their wings match those of their surroundings that, unless the exact points at which they disappear have been carefully noted and immediately approached, it is almost impossible to detect them until they again take flight.

Butterflies are wonderfully strenuous feeders; I have often watched a great swallow-tail travelling eagerly over the soil of a moist hollow on a garden

path and prodding so energetically into the muddy surface that his proboscis was bent like a bow by the force which he used as he hurried round with half-raised and constantly quivering wings. Their eager greed often renders them most efficient agents in securing the cross-fertilisation of the flowers which they frequent, but in certain cases in which they undoubtedly give rise to cross-pollination their services are quite fruitless. A striking example of this is afforded by the barrenness of *Hibiscus rosa-sinensis* in India. This species abounds in every garden in Lower Bengal, but so rarely produces any fruit there that, during a stay of twenty-nine years in the locality, I only heard of one instance in which a shrub produced any capsules, and in that only two were formed. The infertility is certainly not owing to any weakness in the plants, or to the want of abundant flowers providing seemingly normal stigmas and healthy pollen, nor can it be ascribed to any absence of means securing the transfer of materials from the anthers to the stigmas. Owing to the relative positions of the stamens and stigmas, not only is self-pollination rendered almost impossible, but processes of cross-pollination could hardly have been carried out save by the intervention of butterflies of considerable size. There are, however, numbers of these always ready to avail themselves of the rich stores of nectar which lie in the depths of the flowers, and which they can only reach by means of lighting on the summits of the columns bearing the stigmas and stamens, and then forcing their way inwards along their course until they



have reached a level from which their tongues can extend to the point at which the coveted liquid lies. In working their way inwards along the column the under surfaces of their bodies can hardly fail to become thickly smeared with pollen from the broad band of stamens, and when they go on to other flowers the prominent, velvety stigmas are ready to relieve them of part of the burden. In the peculiar variety of the plant in which the flowers hang vertically downwards and have finely fringed margins, the transfer of pollen is equally effectively carried out, but in a different way. Butterflies, on visiting such flowers, alight on the sides of the columns, and while flapping their way upwards towards the corollas coat the tips of their wings with pollen ready to be wiped off upon the projecting stigmatic lobes of subsequently visited blossoms. Very casual observation is all that is needed to show that such processes of transfer are constantly taking place, and yet the flowers almost invariably remain obstinately sterile.

Almost every flower on the entire surface of a large shrub may show the clearest evidences of the occurrence of free pollination, and yet fructification hardly ever follows—some factor is wanting which is essential to the occurrence of effectual fertilisation. Similar results attend artificial cross-pollination of the flowers; a slight delay in the fall of the corollas, and sometimes a little ovarian hypertrophy may take place, but, in spite of numerous experiments, I have never observed any further changes to occur. Instances of this nature certainly suggest the need of caution in framing



theories to account for the absence of fertility in individual kinds of plants in particular localities. There is, perhaps, too great a readiness to explain the defect as the result of the absence of suitable insects or other agents to secure the transfer and application of pollen. Even a single instance, like that of *Hibiscus rosa-sinensis* in India, is enough to show that the presence of vigorous and seemingly quite normal plants, of abundant pollen, and of insects ready to transfer it from flower to flower, does not necessarily secure the production of seed, and that the absence of the latter must be determined by some other factors probably connected with general physiologic abnormalities caused by special features in the environment. When one first comes across plants, like the little deep blue *Ipomæa* and *Parkia biglobosa*, which both flourish in Calcutta and Madras, but which, whilst uniformly sterile in the former, fruit freely in the latter place, the first impulse is to explain the absence or presence of fertility as the outcome of the absence or presence of appropriate insects to secure the occurrence of pollination; but this solution of the problem is at once proved to be insufficient in the light of experimental investigation taken along with the facts regarding the generally diffused infertility of *Hibiscus rosa-sinensis*. In dealing with matters of this kind it must always be borne in mind that the process of pollination normally gives rise to two perfectly distinct results; it determines the occurrence of sexual fertilisation, but it also occasions special stimulation of nutritive activity and supply in

neighbouring tissues to provide for the demands of the outcome of this. But it is quite possible that in some cases it may be wholly inert, and in others only capable of giving rise to one or other of the events normally attending its occurrence ; and that, in consequence of such defective power, it may fail to give rise to any appreciable effects, or at least to any leading to the production of fertile seeds. In cases in which it neither leads to the occurrence of the essential processes of sexual fertilisation, nor to the general nutritive stimulation which is necessary to meet the demands of the new organisms resulting from them, it is evident that no development of seeds can occur ; should it be able to occasion sexual fertilisation alone, the outcome must remain abortive ; and, should it only cause general nutritive stimulation, the formation of fruits may follow, but these will not contain any fertile seeds.

In what has been said hitherto it has been assumed that the failure in the production of seed after the occurrence of pollination is dependent on intrinsic peculiarities in the pollen-grains, but it is possible that in certain cases the fault may lie not in them, but in the stigmatic tissues, in imperfections in the ovules, or in an incapacity in the neighbouring tissues to react to the general stimulant function of the pollen ; and this, of course, only renders it less surprising that the mere occurrence of pollination should often fail to be followed by its normal results. However we elect to explain the sterility of *Hibiscus rosa-sinensis* in India, the facts in regard to the conditions under which it

occurs clearly show that the mere presence of an abundant supply of seemingly healthy pollen and of means securing its transference to apparently normal stigmatic surfaces by no means necessarily leads to the formation of fertile fruits, and that persistent failure in seed production must not be hastily ascribed to the absence of appropriate agents of pollination.

Among the shrubs which prove specially attractive to butterflies, *Euphorbia pulcherrima*, the Poinsettia of gardens, occupies a conspicuous place. When they are in full flower and brave in scarlet bracts, the bushes are constantly haunted by insects of many different kinds. Among the most striking of the visitors are numbers of great butterflies who eagerly suck up the stores of glutinous nectar which fill the cups of the curious yellow-lipped glands of the inflorescence. So long as any supply of sweet liquid can be got at, butterflies are by no means nice in respect to its origin. When the leaves of trees are thickly besmeared with the honeydew attending the presence of numerous aphides, butterflies are very often to be found competing for a share of the sticky delicacy, and vainly attempting to drive off great ants who obstinately refuse to be routed by the most furious buffeting of indignant wings. The same taste sometimes leads them to indulge in fluids of a less innocent nature, and it is by no means unusual to meet with a butterfly who is staggering or fluttering about in a state of hopeless drunkenness after unwise excess in port wine or champagne.

The flower-heads of *Euphorbia pulcherrima* con-

tain a number of distinct groups of bloom, each of them including a single female floret surrounded by several male ones, and a great yellow gland situated on the axile side. The inflorescence is markedly protogynous, the stigmas of the female flowers maturing long before the anthers of the surrounding stamens have ripened. Butterflies in quest of nectar alight on the scarlet bracts which form signboards around the groups of flowers, and reach inwards over the stigmas and stamens in order to get at the glands. After pollination has occurred the styles of the stigmas, which have previously been erect, curve over to one or other side so as to leave the maturing stamens projecting and ready to deposit pollen on any surface which comes against them, whilst the now useless stigmas look directly downwards. The alluring glands begin to secrete whilst the stigmas are still erect, and continue to do so after they have bent over. The final outcome of all these arrangements is that any butterfly who visits an already fertilised group of flowers becomes coated beneath by pollen, part of which almost necessarily comes in contact with the stigma of the next unfertilised group which is attacked. Various kinds of ants are also very fond of the nectar, but, as they reach the glands by climbing directly up from below, do not play any efficient part in the transfer of pollen.

The masses of fallen and withered leaves which strew the ground in shrubberies are constantly frequented by butterflies whose sombre tints of brown and ochre harmonise with those of their surroundings. In one highly ornamental species



the prevailing hue of the upper surfaces is of such a pure strong cobalt as to render the insects very conspicuous whilst flying, and the effect is almost magical when one of them suddenly alights and vanishes from sight as it raises its wings and presents their dingy under sides to the observer. Even more noteworthy is the elaborately protective resemblance in another butterfly in which the wings are not only soberly coloured throughout, but also peculiarly modified in form, so that when raised their tips do not lie flat, but are twisted to one side, so as to simulate the curving contours so often present in withered leaves. Wonderful examples of protective colouring are often present among moths and butterflies occurring in other and very different environments in any large Indian garden. Specimens of those butterflies which mimic fading but still adherent leaves are occasionally to be met with. In the species which is commonest in the neighbourhood of Calcutta, the wings are of a bright brown colour, and when raised present an outline exactly like that of a broad fading leaf, in which part of one side of the blade has been broken off. The outer and hinder angles of the back pair of wings are prolonged so as to represent a short leaf-stalk, and a line runs up from this to the tips of the forewings to form a phantom mid-rib, whilst black dots irregularly scattered over the surface on either side play the part of the dark-coloured fruits of lichens. Perhaps the most remarkable of the deceptive features is that the margins of the wings do not come into continuous contact, but are wavy, and so leave interspaces

exactly like those which are so often to be seen at the edges of a withering leaf in which the upper and lower layers of epidermis have begun to separate from one another owing to decay of the soft intermediate tissue. Such an insect whilst flying is a very conspicuous object; but when it settles in a leafy shrub, raises its wings, and brings the tips of the hinder ones in contact with the twig on which it rests, the mimicry of an adherent fading leaf becomes so perfect as to provide effectual concealment even at very close quarters.

In a species of moth, which habitually rests among withered blades of grass, the wings are margined and obliquely barred by pale ochre on a deep brown ground so as to be practically invisible amid the alternating lines of yellow and strong shade in the environment. In another moth the character of the elaborately protective colouring suggests a curious problem. Its wings are of a pure chalky white minutely dotted over by scattered specks of grey, so that when the insect occupies its wonted resting-place on a white-washed wall it is only distinguishable on very close inspection. The scheme of colouring is so elaborately like that of any lime-washed surface in which minute particles of sand stand out against a chalky background that it is hard to imagine that it can have been evolved in any other connection, and that we are not dealing with an example of evolutionary adaptation which has been worked out within the relatively brief period which has elapsed since human beings began to use lime-wash.

In many cases, however, it is impossible to detect any protective element in the colouring of butterflies. There is one charming creature who haunts the green jungles of long grass on the margins of ponds, and who is dressed in such bright brown wings and scarlet eyes that her clothing seems adapted to make rather for public recognition than for Montaigne's *arrière boutique*. Another very conspicuous insect is a moth who specially loves logwood trees. In it the wings are richly painted in orange and black, the abdomen banded in black and red, and the head and antennæ brilliant blue. Bright colours may of course advertise the presence of offensive properties, and so become indirectly protective, or they may serve as a sexual attraction. In so far as the latter end is concerned, however, they do not always seem to favour a high standard of morality, for now and then a light-minded insect may be seen to show unequivocal signs of having fallen deeply in love with a lady of totally distinct species and gaudy dress. It is satisfactory to know that such levity is not invariably approved, and may even be forcibly put a stop to. I once saw a white butterfly making violent and persevering advances to a bright yellow one of another species, until a much larger grey insect, who seemed to be sadly shocked at such irregular conduct, flew hastily up and drove him away. We are hardly ready enough to credit other animals with any sense of propriety or decency, and too much disposed to regard it as a peculiar human endowment. There was once an old

peacock in the Zoological Garden in Calcutta who, either as the result of advancing years or of some other occult cause, failed to become provided with a train at the close of one moulting season. Of this, however, he seemed to be blissfully unaware, and in due course proceeded to set up his short turkey-like tail to the utmost, and to strut, wheel, and back about as though he were decked in the full pomp of nuptial attire. The show was almost sad in its disgraceful folly, but fortunately it was usually of very short duration, for no sooner did a peahen who lived in the same enclosure observe that the unseemly performance was going on than she brought it to an abrupt end by a violent assault, under the influence of which the actor was glad hurriedly to furl his supposed magnificence and escape from a storm of pecks and buffetings.

Great sphynx-moths abound in the neighbourhood of Calcutta, and at night the lights of rooms often lure in "death's heads," who come wandering in, and in the shadows present a very weird aspect, owing to the way in which their eyes shine out like little ruby-tinted lamps. Some of the larger hawk moths have strangely transparent wings, and as they dart hither and thither in loudly humming flight might well be taken for monstrous hornets. One loudly humming but uniformly feathered species is often to be met with hovering over groups of canes, and is probably the mature representative of strange white chrysalids who inhabit chambers built out of the pinnæ of the leaves rolled up and tied together by shining white webbing. 'The most remarkable thing about



these pupæ is the startling way in which they resent any interference with their habitations. They hang freely suspended from the ends of these by cords of web, and when the leaves are handled shake themselves violently about, bringing their bodies sharply and repeatedly against the hard surfaces of the surrounding walls, and so causing a sudden clattering sound of such a nervously irritant quality as to be well fitted to scare away prying birds.

It is needless to enter into any details regarding the manners and customs of "clothes-moths" in India, as their ravages are not peculiar to tropical regions, but there is one point in respect to the commonest species of them in Calcutta which is perhaps worthy of notice. When I first arrived in the town in the late sixties of last century many European houses were treated in a very casual fashion. No modern idea of æsthetics had yet dawned on Anglo-India; the furniture was scanty and unspeakably hideous, and the utmost that was done to render rooms habitable was a careful avoidance of all unnecessary hangings and an application of so-called "decoration" in the form of rudimentary stencilled borders to the lime-washed walls. The nakedness of everything was regarded as providing such efficient protection that operations of sweeping and dusting were usually left almost entirely to the discretion of the servants, with the result that the rooms became perfect preserves for various kinds of insects. In those days the larvæ of clothes-moths walked about everywhere over the

walls in little ambulatory coffins, like miniatures of the Maid of the Alder-tree in George Macdonald's *Phantastes*; but in the course of years modern views on decoration and sanitation gradually asserted themselves, and long before I left India such curious little mummy-cases were rarely to be seen in any well-ordered house.

## CHAPTER VI

### BEETLES

When the water-beetle with great blind deaf face  
Made of her eggs the stately deposit.

BROWNING.

Her Eyes the Glow-worm lend thee,  
The Shooting Starres attend thee ;  
And the Elves also,  
Whose little eyes glow,  
Like the sparks of fire, befriend thee.

HERRICK.

BEETLES are hardly so likely to draw the attention of the casual observer as many other kinds of insects, but there are some of them who can scarcely escape notice owing to their mischievous habits or their wonderful and beautiful peculiarities. Amongst the most afflictive trials of a book-lover in India are the devastations caused by so-called book-worms, the grubs of a small species of beetle. It is hard to imagine the feelings of grief and indignation which attend the discovery that cherished volumes, which have been standing on the shelves in fair outward show, are in reality mere whited sepulchres, riddled by innumerable tunnels, which have loosened the bindings and may even have penetrated the entire thickness of their contents. People who are new to a locality in which the pest prevails are apt to imagine that

they have effectually provided for the safety of their treasures by housing them, if not "in a Sheraton shrine," at least "in an odour of camphor," and securely locked up in glazed cases to prevent the invasions of that "fell minister of fate" the bearer, with his dirty dusters and rough fingers; but a very brief experience is usually enough to lead to a painful conviction of the insufficiency of the treatment. Even when the closure of the cases is most efficient and the air within them so thoroughly saturated with the vapour of camphor that any considerable fall in temperature is followed by a deposit of crystals sufficient to render the glasses hazy, the book-worms work on gaily, and often render whole volumes unsightly or even illegible within a very short time. When one of their burrows is followed out whilst still occupied, the further end of it is found tenanted by a small yellowish-white grub with a dark head and a pair of strong jaws; or the inmate may be a miniature chrysalis, or sometimes the corpse of a little brown beetle who has not been able to find his way out of his cavern. In most cases the tunnels are specially numerous in and close to the boards of books, and often the whole substance of the binding is so thoroughly riddled by passages crossing one another in every direction as to be quite friable. In any case the mischief usually starts in the bindings, and sometimes it is almost wholly confined to them; but now and then tunnels are to be met with lying throughout their entire course within the paging and devoid of any visible openings on the surface of the book.



The abundance of borings in the bindings is to be accounted for as the result of the facts that the parents of the grubs usually only find convenient opportunities of laying their eggs on books which are standing closed and undisturbed on shelves, and that the abundance of size in and about the covers provides stores of suitable food there for the grubs. Occasionally, however, an insect may come across a book which has been left open or only loosely closed, and should it elect to lay on the exposed pages and the volume be subsequently firmly shut, the natural result will be the formation of a blind cavern. But in any well-ordered and book-loving house, volumes are not left to lie about open for any considerable time, and hence almost complete protection is provided to any book which has not yet been invaded, by means of washing the boards, back, and fly-leaves with a strong solution of corrosive sublimate.

Should a spirituous solution be used, there is little reason to dread the occurrence of any evil from the treatment. As a rule the utmost visible evidence which it leaves behind is a slight white efflorescence of crystals, which can be easily rubbed off from the surface of the binding; but this is rarely present, for the liquid is so penetrative that it is only where it has been applied in quite unnecessary amount that enough remains unabsorbed to occasion any perceptible deposit. The solution, moreover, is so little solvent of the colours commonly used in dyeing the cloth or leather of bindings that there is very small risk of its causing them to run. It is also quite

innocuous to gilding, though this is not the case in respect to any silvered lettering or ornament. A favourite old servant, one of whose routine duties lay in poisoning each new book as it came into the house, was once greatly shocked when he treated a volume of *The Royal Natural History* in the usual way and found that a large silvered representation of a snow-leopard, with which the front board was disfigured, vanished away, leaving a respectable surface of plain brown cloth behind.

Such superficial treatment is not enough in dealing with books which have already been occupied by the enemy, and it is then necessary to go carefully through their whole thickness, washing over whole pages in many places, carefully saturating the back edges, the stitching and size of the binding, and picking out all the grubs who lurk in the depths of the tunnels. When the maggots are taken out they are "strangely and wonderfully" tenacious of life, and will swim about quite cheerfully for more than half an hour in pools of the poison, probably because they are coated in some cutaneous excretion which prevents liquids from coming readily into direct contact with their bodies.

Some kinds of beetles do enough mischief in gardens to be almost certain of attracting notice. There is one pernicious creature, dressed in bright orange, who at certain times of year advertises his presence by the havoc which he plays among treasured vegetables, chewing up the most lovely petals and sometimes even cutting off whole heads of bloom with his powerfully incisive jaws. But

the harm that is done by these and other ruthless creatures is more than atoned for by the wonderful beauty of some of their harmless relatives. Every now and then a shrub will be alive with lovely little beings, who are clothed in broad shields of transparent, glassy texture, through which the metallic colours of the parts beneath shine brilliantly out ; and occasionally these are accompanied or replaced by larger insects glorious in green, gold, carmine, and white. The peculiar purity of the white tints in the colouring of many beetles is very striking. There is one great longicorn who sometimes wanders into lighted rooms at night, to display a most effective contrast between the bright umber of his wing-covers and the snowy whiteness of his under surface. Some other large beetles are much less welcome nocturnal visitors. One of the commonest of these is a black monster who comes buzzing and blundering in, dashing recklessly up against the walls, pankhas, or human occupants of the room, to fall headlong down and lie helplessly sprawling on his back or cling tenaciously to the first object on which he can fasten his spiny legs and curved claws. What renders any immediate contact with insects of this kind specially unpleasant is that they are usually infested by numbers of most repulsive parasites, who adhere to the softer tissues between the thick plates of armour clothing the bodies of their hosts. One of the most amusing visitors is a great horned beetle who possesses a most startling power of stridulation. When one of them comes in and falls to the floor he walks quietly and sedately

about so long as he is left to his own devices ; but whenever he is in any way alarmed or interfered with, he suddenly sits up on his hind legs and, whilst brandishing his jagged and hooked forepaws aloft, emits a sound like that of a miniature engine blowing off steam. This performance is seemingly as alarming to dogs as it is to human beings who are unprepared for its occurrence. One hot, still October night, when a friend and I were quietly seated at dinner, one of these beetles flew into the room and in due course fell down with a sounding flop on to the matting of the floor. A long-haired Scottish terrier, who was always on the outlook for *shikar* of any sort, was present, and at once on the spot to inquire into the cause of the disturbance. The intruder at first lured her on to close investigation by minatory gesticulations and then drove her wild with terror by stridulating loudly and fastening on to the hair of her muzzle. The result was wild panic and immediate flight, in the course of which she rushed violently under the sideboard, where a number of bottles of soda-water were lying and completed her discomfiture by bursting with a series of loud reports (Plate II.).

In any place in which they abound, there are very few other kinds of beetles so sure to attract the notice of a new-comer as fireflies are. The steady flame of the greenish lamps of glow-worms is undoubtedly very beautiful, but it cannot compete in charm with the effects produced by the intermittent flashing of the lights of myriads of fireflies swarming amid heavy masses of foliage or wandering fitfully round through the black air of



a still and moonless night. Nearly forty years ago, when I first knew the place, fireflies were abundant in the immediate neighbourhood of Calcutta, and, throughout a great part of the year, used to provide brilliant nightly illuminations in every suburban garden; but more recently their numbers have undergone a progressive and considerable decrease, probably as the result of diminished moisture in the air and soil caused by improved drainage. It was usually during the rainy season that the finest displays took place, but all throughout the winter and summer months scattered lights were to be seen wandering over the lawns and among the trees and shrubs, unless on occasions when the weather was exceptionally dry or cold. In winter, fireflies would sometimes almost entirely vanish for a time, but on any slight rise in temperature they were ready to reappear, and a brief fall of rain was all that was needed to secure a general resurrection. After any of the sudden storms which sometimes take place in January and February it is always most interesting to watch them coming out. Hardly has enough rain fallen to moisten the surface of the hard and dry soil before they begin to emerge and sail off into the air. Not that they ever issue forth in dense localised hordes like those of white ants, but they often appear in such large numbers that after dark the whole surfaces of lawns are thickly sprinkled over with sparks of pale light, forcing their way up through all the cracks in the baked earth, mounting to the tips of the blades of grass, and wandering off into the surrounding air.

Occasionally during the rainy season whole trees are tenanted by myriads of flashlights, and all the air around alive with floating sparks; but the shows in the country near Calcutta were never, even in old times, equal to those which take place in many other parts of India. The grandest displays that I have ever seen are those which occur in the Tarai and other low land at the foot of the Sikkim and Bhutan Himalaya. My first experience of them was one night whilst driving along the old road between Titaliya and Siliguri. Everywhere the air was full of lights; all the roadside trees were aflame; and the great ditches on either side of the track were brimming over with drifting clouds and streams of sparks wandering to and fro in ceaseless and bewildering tangles. In this region, too, very striking examples of mysteriously synchronous action on the part of whole hosts of the insects are often to be seen. This phenomenon is by no means peculiar to any particular part of the country, but in most places it occurs rarely and only in limited degree. I have seen a very fine show of it in a mango-tree close to one of the gates of the Botanic Garden at Shibpur, and one of the very first magnitude not far from Bombay during a journey up the Eggatpura Ghàt on a dark night when the first showers of the monsoon had just begun to moisten the slopes of the hills on either side of the railway. As the train slowly panted upwards, many of the trees alternately flamed out into dazzling splendour and vanished off in the gathering gloom of an impending storm, whilst the hosts of insects resting

in them lit and put out their lamps as though by common consent. The cause for such simultaneous action on the part of countless individual insects is hard to imagine, but there can be no question of the fact that such displays do take place.

Glow-worms, if they occur at all there, must be very rare in the country round Calcutta, for I certainly never saw a single specimen during the course of my long residence in that place. They are, however, common in other parts of India, and are often very conspicuous in some of the hill-stations. They abound in some parts of the Nilgiri Plateau and the Simla Hills, and are there endowed with lamps which far surpass those of the common British species in splendour. Unless for the satisfaction of scientific curiosity, it is well to be content with the beauty of the illumination and not pry too closely into its origin, for the torch-bearers are of a very repulsive aspect, and closely resemble monstrous white maggots. Their lights are certainly fine enough to cover a multitude of sins as they shine out of the grass and weeds of wayside banks, like little electric lamps of the purest green radiance.

## CHAPTER VII

### DRAGON-FLIES, WHITE-ANTS, ETC.

The lilies revived, and the dragon-fly  
Came back to dream by the river.

MRS. BROWNING.

To any one who is making believe to enjoy himself by sitting out on a lawn on a still damp evening in the end of summer or the beginning of the rainy season surmounted by a columnar cloud of mosquitoes, which rises like a thick mist over his head as though he were a Djinn in process of condensation or resolution, it is always cheering to become aware that the dull humming drone of his uninvited attendants has been interrupted by a sudden, sharply whirring sound, and to see a great black and gold dragon-fly sweeping hither and thither through the throng, picking up and devouring one victim after another in his destructive progress. This is a very pleasing experience; but, at the close of summer and when the longing for rain to wash down the dust and allay the stifling heat has been steadily growing with each successive day, even greater and more lasting joy attends the sight of dull brown insects, drifting in clouds through the air and settling in long files on the telegraph wires and railings at



the sides of the dry roads ; for, like Emily in *The Mysteries of Udolpho*, they are subject to “prophetic apprehensions,” and their appearance is one of the most trustworthy harbingers of the monsoon. Bull-frogs, and even the great autumnal crickets, may be deluded into premature bellowing and whirring by the occurrence of casual heavy showers, but these brown dragon-flies appear to have a finer meteorologic sense and very rarely appear in force until continuously damp weather is about to set in. Their advent is, therefore, a welcome event, unlike that of their relatives with spotted wings who come out in hovering clouds in spring, and go wavering about in a feeble fashion to announce only too surely that “winter is over and gone,” and that the season for heat and patience has arrived. These spring flies are curious creatures ; they have none of the restless energy characteristic of most of their larger relatives ; they are never to be seen rushing about on marauding excursions, but spend their time in hanging aloft in the air, supported by laboured flappings of great gauzy wings which seem to be almost as little under control as those of white-ants. They usually keep together in large companies which persistently haunt particular places, and these by no means always in the immediate neighbourhood of water.

Every garden is full of dragon-flies, but it is only on the banks of ponds that it is constantly possible to form any just idea of the wonderful varieties of form and colouring that they may present, for it is only there that the most brilliant

species are to be met with. There, amid the jungles of long grasses, reeds, water-lilies, and other floating and anchored vegetation, multitudes of slender little creatures are constantly to be seen, not rushing and darting about like the great banded or brown flies, or wavering in clouds like those with spotted wings, but gliding quietly along like little gaily dressed ghosts, living threads of brightest scarlet, vivid green, cobalt, gamboge, or warm brown, crossing and recrossing one another "among the grass and weeds that shield them from the view." It is there too that the curious events attending the deposit of their eggs can constantly be studied at close quarters. Every now and then a pair of insects glides by firmly anchored to each other because the upper one holds the back of the thorax of its comrade lightly grasped between the blades of the vice in which its body ends. The pair represents a married couple in quest of a suitable site in which to give their children a fair start in life. The husband is the upper insect, and he and his wife are often dressed very differently. In one common species, for example, he is painted in the brightest turquoise blue, while she is soberly attired in pale, dull ochre shaded with greenish and dingy blue. When the anxious pair meet with a stalk or blade of grass, or a petiole or twig on some other aquatic weed of a satisfactory nature, the male alights on it close to the surface of the water, and, keeping a firm hold on his wife whilst she descends into it, is ready to assist her exit by dragging her upwards after she has laid an egg. In some cases a

fastidious lady does not find a completely suitable site until she has been wholly submerged, and then her poor husband has very hard work in extracting her by means of labouring upwards into the air, but very often a place quite close to the surface is approved of, and occasionally a particularly ignorant, careless, or lazy female is content to lay above the water. When the work has been satisfactorily accomplished the insects at once continue their travels in search of a new place in which it may be repeated (Plate VII.).

The eggs are curious objects, consisting of curved, pointed rods, each arising from a short horizontal bar which serves to attach them to the bodies on which they rest. It now and then happens that a site is chosen in which there is no handy perch for the male, and then he has a hard task indeed, as not only has he to drag his wife out after she has laid her egg, but he has also to hover vigorously aloft all the time she is in the water in order to be ready to help her up when the proper time comes. It is easy to see the benefits accruing from the subaqueous deposit of the eggs, for, when beneath the surface of the water, they are safe from the raids of the great brown hornets and other predaceous insects who are for ever questing round the margins of ponds in search of booty. The protection may be but transitory at times when the level of the water is sinking owing to continued evaporative loss, but, so long as the eggs are submerged, they do enjoy immunity from certain risks; and hence, the deeper the original submersion, the greater is the chance of their surviving and



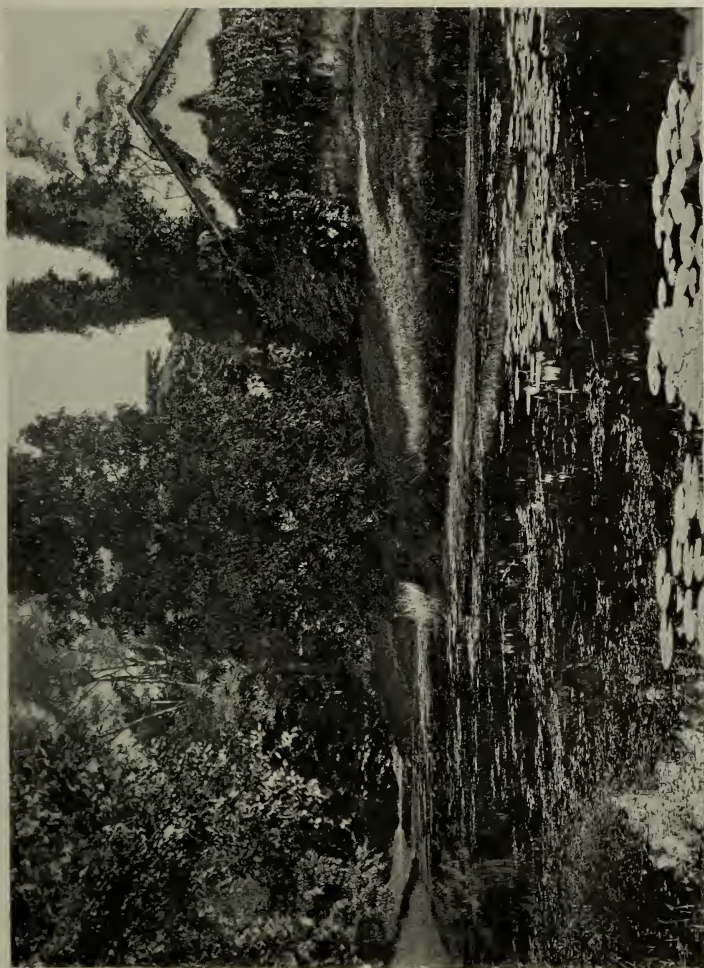


PLATE VII.—A HAUNT OF DRAGON-FLIES.





undergoing evolution. It is easy, therefore, to see how processes of natural selection and heredity may have served to fix and elaborate the habit of laying beneath the surface of water, but it is not so easy to explain the origin of the co-operative action of the two sexes which allows of its most efficient performance, or to imagine the series of steps by which it acquired its present highly purposive character.

Inoffensive, slender dragon-flies, like those which have just been mentioned, are sometimes rudely and wantonly assaulted by their larger, more energetic relations. I have seen a great brown ruffian who was hawking about overhead, make a sudden, swooping descent on a wholly unoffending slender blue fly gliding quietly about on its own affairs, and knock it heels over head with such violence that it fell swooning on to a leaf beneath and lay there for some time unconscious and motionless before it was able to pull itself together and again take wing. Almost all the larger kinds of dragon-flies have a quaint way on alighting of bringing their wings forward in a series of sudden sharp jerks until the tips of the front pair come to project considerably in advance of the head, the outcome of the action probably serving a respiratory end in opening out the orifices of some of the most important air-tubes. The numbers in which the common large brown dragon-flies suddenly appear at the onset of the rainy season are quite astonishing. For many weeks hardly a single specimen has been visible, and almost the only large species in evidence has been that with spotted wings and feeble flight, and then, within the course of a few hours, the air is

full of drifting hosts of great creatures swooping to and fro overhead, while others sit in endless files on all the telegraph wires and rails, jerking their gauzy wings and gazing curiously round with huge goggle-eyes. During the whole course of the rainy months they are present in great numbers, but it is only when the air begins to dry up in autumn that they again show any inclination to assemble in crowds.

The smaller species are, quite apart from risks of assault from larger and stronger ones, exposed to many dangers of purely local origin in the course of their devious wanderings through the aquatic jungles which they haunt and which are peopled by many kinds of ferocious creatures constantly on the outlook for prey. Among the most formidable of these are strange spiders, who present a curious likeness to the water-boatmen who are constantly sliding about over the spaces of open water. They spread delicate and almost invisible webs over the layers of floating leaves which form carpets through which grasses and other erect weeds shoot up into the air, and in these snares small dragon-flies often become entangled. Even the gentlest and smallest prisoner, however, usually makes a brave struggle for liberty, and may for a time prevent the approach of the captor, or even break loose and fly away carrying off trailing fragments of web. In such circumstances the captives make use of their long wiry bodies with great effect, curving them upwards in abrupt loops and then suddenly straightening them out so as to strain violently on the texture of the entangling webs.

On the arrival of cool and relatively dry weather in October or the early parts of November, dragon-flies become much less abundant than they are during the rainy season ; those with spotted wings vanish entirely until the temperature has risen considerably in the following spring ; the monstrous banded ones cease to swoop and dash about over the water ; even the common brown ones are rarely to be seen ; and as the fringes of vegetation round the edges of ponds narrow and dry up they become less and less adapted to harbour many of the smaller species. All dragon-flies are most fascinating creatures, the larger ones from their fierce and fearless energy, and the smaller kinds from the extreme grace and elegance of their forms and movements, and, in many cases, owing to the wonderful beauty and brilliance of their colours. Even the larger and coarser species are often splendid objects whilst hawking round on stiff and rustling wings on which the oblique sunshine strikes to make them look as though they were woven out of golden threads knotted into a delicate lace-work of shining meshes.

The texture of the wings varies greatly in different kinds of dragon-flies. In many of the smaller species it is so thin and transparent as to be invisible at a short distance, so that the insects as they travel gently about come to look like little moving rods, painted in the gayest colours and seemingly impelled by psychic force. In other cases the network of veins forming the framework of the wings is so hard and stiff as to cause a loud, rustling murmur during rapid flight ; and in certain



instances the wings, although stoutly built, seem to be so feebly attached to the body and so little subject to voluntary impulse that their movements are always of an uncertain and wavering nature utterly unfit to allow of the furiously sweeping flight which is so characteristic of many of the larger species. One of the most remarkable points in many dragon-flies is the curious way in which their huge eyes are divided into upper and lower halves of utterly unlike appearance and presumably of distinct functions. The legs of dragon-flies are not so well adapted to meet all the emergencies of predaceous life as those of many wasps are, for they are not long and strong enough to secure a firm footing to their owners when obliged to come to the ground whilst carrying some bulky prey. A great dragon-fly once darted in at an open window in front of which I was working, and tried to settle on a bundle of papers at my elbow in order to make a meal off a fat spider which he had captured. The legs of his prey were, however, too long to allow him to get a good foothold, and, after a short tussle, both captor and captive rolled over and fell back-downwards on the table. The experience did not seem to be at all new or startling to the fly, for he placidly devoured the greater part of his victim with his heels in the air and then quietly got up and flew off, leaving a litter of yellow legs and other arachnidan débris as a memento of his visit. What really does seem to incommode dragon-flies greatly is to have their wings heavily laden with moisture. In the early morning in Calcutta everything is usually drenched

with dew, and dragon-flies are constantly to be seen so heavily burdened with shining beads of water as to be quite unable to fly, and hardly even to crawl about until the sunshine has arrived to relieve them of their loads. It is a gradual accumulation of moisture which troubles them, not a sudden encounter with it in the form of large falling drops; the common large brown flies will often continue to swoop and dart about during the course of showers of rain heavy enough to drive most birds to cover; but on perfectly still, damp, cloudy days they spend most of their time motionless, sitting patiently with widely spread wings on leaves, twigs, telegraph-wires, and other convenient perches until a change of weather sets in.

Most of the larger and more energetic dragon-flies are somewhat soberly coloured, but there are exceptions, and now and then great creatures—streaks of bright scarlet, cobalt, or gamboge—are to be seen darting about through the air over a pond. One of the finest of all the large species is a giant dressed in ruddy gold, turquoise blue, and pale yellow, and as he goes hawking about over the water his great wings shine in iridescent colours when he hangs dreaming in the sunshine during the brief pauses in the course of his furious flights. He is a truly formidable-looking person, and is so bold and aggressive in his ways that even those braves, the large brown hornets, fight shy of him. Just as in the case of the common small kingfisher, attention is often first attracted to the presence of one of these great insects, not by direct vision, but by the sight of his reflected

image darting across the shining mirror of a pond. It seems somewhat strange that it should be among the smaller and feebler species that conspicuous and brilliant colouring is the rule, whilst among those whose strength and ferocity would seem to demand them least, protective tints so often are present.

Tales regarding white-ants—who, by the way, are not ants at all, but really relatives of dragon-flies or mayflies—are so familiar to every one that it seems doubtful whether it is desirable to make any special mention of them. But, at the same time, any record of the common insects of Indian houses and gardens which failed to take any notice of these “infestuous vermine,” as old Parkinson calls “earwickses,” would be somewhat like a performance of *Hamlet* with the name-rôle left out. Luckily for the inhabitants of the lower Gangetic delta, the region is not nearly so much infested by these destructive creatures as many other parts of the Peninsula are. The excessive moisture which prevails throughout it, and which in many other respects tends to make life particularly burdensome, has at least this advantage, that it produces an environment which is much less congenial to them than that in dryer regions is. But, even so, they often abound in dementing degree, and occasion very serious mischief and trouble in spite of ceaseless vigilance against their devastating irruptions.

What makes the task of successful conflict with them a particularly hard one is that they conduct their ravages not only with almost incredible

energy and perseverance, but in a wonderfully furtive fashion, owing to the extreme dislike to any exposure to sunlight which leads them to work as long as possible under the natural cover of any material which they have invaded. It is only in cases where specially alluring materials lie on the surface in irresistible profusion that the presence of white-ants is openly revealed, save by the covered ways which they throw up in order to connect their exhausted mines with new workings; but when they find the bark of a tree or shrub particularly attractive, they often cover the whole of it with a continuous layer of mud, and sometimes even raise great mounds of earth around the bases of the stems and lower branches so as to bury them in a common grave. As a rule, however, Indian white-ants do not raise conspicuous edifices above the surface of the soil; their fastnesses lie deeply buried, and the superficial structures which they occasionally rear are mere shelters beneath which they can comfortably secure food and building materials, or covered ways leading from one to another of their grazing-grounds.

It is mainly owing to their furtive ways that they are often able to do so much harm, for in consequence of them they may easily conduct extensive devastations even in well-ordered and constantly inhabited rooms before their presence has been suspected. The fact that a beam in the roof of a room has been rendered quite untrustworthy by their excavations is often only revealed when they desert it and, in order to make their way to another,



throw up a covered way, like a muddy earthworm, over the paint or plaster between it and a neighbouring one. When they have once found a beam or other mass of material to their taste they go on devouring the interior of it until nothing remains save a thin outer shell and a network of slim partitions separating a maze of passages and caves; so that, on establishing themselves in a house, they may soon reduce a great part of the woodwork in it to a mere fragile whited sepulchre. It is, therefore, necessary to maintain sleepless vigilance in order to detect the slightest traces of their presence, and specially for the first appearance of any of their covered ways on the surfaces of walls and beams. In one house in the suburbs of Calcutta in which I lived for some time, the lower flight of the wooden staircase, whilst showing no outward signs of infirmity, became so fragile as to give way beneath the feet of those who mounted it, and when it was examined and repaired the whole fabric was found to have been entirely eaten away, save a thin superficial layer of painted wood.

The ground floors of houses are naturally most subject to invasion, but any points in the walls of a building which contain faults or cracks may serve as highways by which the upper floors may be reached. Sometimes, and doubtless owing to the presence of particular structural defects, the first floor of a house may escape, whilst one or other of the higher ones is subject to repeated invasion. This was formerly the case in the house of the Superintendent of the Botanic Gardens at Shibpur,

in which, whilst the first floor enjoyed almost complete immunity, the ground floor and the western side of the second one were often attacked. Any attempt at invasion can, when detected soon enough, be readily repelled by appropriate treatment directed to the line of march. Strong brown carbolic acid when freely poured into the crevices leading to the highways of the enemy is very efficient; but, as in conflicts with other insect foes, solutions of corrosive sublimate are even more trustworthy. A single application of the latter reagent is usually enough to arrest an inroad for good and all; for, not only is it quickly fatal to all the insects with which it primarily comes in contact, but, as it is readily absorbed and not quickly volatile, it remains for some time in the substance of the walls of the passages and also in the tissues of its first victims, which thus become a means of spreading mortality owing to the cannibal habits of their fellows. One corner of the book-room in my last house in Calcutta was subject to periodic invasions along the course of a crack in one of the outer walls which extended down to the basement; but, thanks to careful watching and occasional free administration of spirituous solutions of corrosive sublimate wherever there were any signs of fresh attempts at irruption, the injury always remained trifling, and was limited to destruction of a little of the matting on the floor and superficial erosions of boots or pieces of furniture close to the points of exit. In all such cases I made use of a solution which was always kept in hand for the purpose of poisoning books in order to save them from the

tender mercies of book-worms, fish-insects, cockroaches, and moths. It contained twenty grains of the sublimate to each ounce of rectified spirit, and, in a climate of such high relative humidity as that of Lower Bengal, there is certainly no appreciable risk attending the use of such or even much stronger solutions. During the course of the long period of years in which I was intimate with the history of the Herbarium in the Botanic Gardens at Shibpur I never heard of a single instance of any ill effects resulting from the fact that, as a matter of ordinary routine, every sheet of mounted specimens was washed over with a saturated spirituous solution of corrosive sublimate so freely that there was usually an abundant efflorescence of crystals of the salt on all the leaves and stalks of the plants. There is certainly no other reagent nearly so efficient in rendering materials exempt from the attacks of insects and fungi. During a long series of years all my books were treated with it, each new volume as it arrived from Europe being carefully washed with it externally and between the boards and fly-leaves before being placed on the shelf, and during the same period every newly acquired Central Asian or Persian rug was immediately treated in like fashion. Moreover, every time that freshly laid matting introduced a temporary plague of fleas into a room the floor was thoroughly drenched with the solution by means of a garden syringe, and yet in only a single instance did any mischief result. In this exceptional case, too, the evil could not be fairly ascribed to the reagent, as it was really owing to the ignorance



and sloth of the servant who administered it. He was in charge of my books, and as a matter of course was used to poison all of them as they came in ; a bottle of the solution, a wooden Tibetan cup, and a large paint-brush being at his disposal in order to allow of his carrying out the work safely. On one occasion, however, nearly one hundred newly bound books arrived at once, and then, in order to save time and trouble, he chose, without consulting me, to discard the statutory apparatus and replace it by a basin and sponge. The result of this was that, as he had numerous cracks in the skin of his hands, he absorbed enough of the sublimate to give rise to great local irritation, and even to some symptoms of general mercurial poisoning which made him very unhappy for some days, and served to instil a wholesome caution in respect to thinking for himself.

Whilst it is relatively easy to repel the invasions of colonies of white-ants, it is a very serious task to dislodge any settlements which have been allowed to establish themselves in the interior of a house. Such successful invasions are specially apt to occur in the case of houses which remain unoccupied for any considerable time, and particularly when the rooms are floored with wood in place of masonry. Almost every one must have known cases in which the life of the inmates of certain houses was for a time rendered almost intolerable in connection with persistent conflict with colonies of white-ants. I can recall two instances in which friends of mine had to struggle continuously with colonies which were in possession of their houses when they entered



them. Whilst matters were at the worst it was necessary daily to dislodge every piece of wooden furniture and every rug or carpet in the affected rooms in order to see whether they had been attacked. Even after solutions of corrosive sublimate had been so freely administered to the floors as to drip from the ceilings of the rooms beneath, it was not until after a considerable time that the enemy was finally expelled. The results seemed to show that the insects are not very readily affected by mere contact with the reagent, and that it is only when the materials which they attack have been saturated with it that a really satisfactory result is arrived at. I never tried any direct experiments in order to settle this question, but, as has already been pointed out, there can be no question that the grubs of book-worms appear to be uninjured by immersion in strong spirituous solutions for at least half an hour, and the surfaces of their bodies in texture and appearance are very like those of white-ants.

The first sight of the emergence of a swarm of winged white-ants must always be a memorable event in the experience of any one interested in the study of the ways of insects; and, even after the longest use, it continues to present features of absorbing attraction. In damp regions like Lower Bengal swarms may come out at any time of year, but in the neighbourhood of Calcutta, at any rate, they do so oftenest towards the close of the rainy season, and again in spring, when sudden drenching falls of rain often attend storms of thunder and wind. Periods of prolonged

drought or of persistent rain are alike unfavourable to their appearance, but the occurrence of brief, heavy showers is very often the signal for it, and it is this that serves to determine the seasonal phenomena of exodus. During the course of winter, and again in the latter part of the hot weather, continuous drought is a repressive factor which is replaced in the earlier part of the rainy season by excessive and persistent moisture, whilst autumn and spring are alike in providing alternating periods of heavy downpours and brilliant warm sunshine. At any time of year, however, when the latter conditions are present they are certain to lead to the occurrence of swarming; and hence in exceptional years with abnormal prevalence of rain in winter and late summer, or scanty and intermittent rainfall during the monsoon, swarms may emerge throughout the greater part of the entire annual period. The fact of the emergence of a swarm may sometimes escape notice until the place of exit has been so closely approached that the observer suddenly finds himself wading in a struggling throng of insects, and surrounded by a mist of flying ones; but in most cases attention is sure to be attracted to the event from some distance by the peculiar behaviour of the flocks of crows, kites, and other birds, who stream in from every quarter to avail themselves of the feast, and wheel about in tangled mazes of flight, eagerly competing for a share in the booty. The kites sail and circle round on seemingly motionless wings, picking up the fluttering insects with their claws

and handing them on to their beaks without disturbing their even course; but the crows hurry about in an urgently flapping way, and every now and then suddenly flutter upwards to secure a victim. The presence of such formidable competitors is usually enough to deter smaller birds from entering the turmoil, but now and then a few bold king-crows or bee-eaters will venture to do so, and on the ground below gabbling troops of babblers and eager magpie-robins greedily attack the stores of succulent food. Whenever a few crows or kites have detected the exit of a swarm the peculiar characters of their flight is enough to advertise the event over all the immediate neighbourhood; in a very short time parties of their relations begin to stream in towards the centre of attraction, and, as they do so, serve to spread the good news farther and farther out, so that it is not long before the impromptu banquet is attended by throngs of eager guests. Should a swarm emerge in full daylight its chances are bad enough, but when it does so towards sunset or in the early dusk they are even worse; for at that time the crows are already at leisure and congregated to gossip before retiring to bed, and are likely to be joined not only by kites, but also by myriads of bats, who go flickering in and out among the crowds of sailing and fluttering birds.

Birds and bats, however, are not the only enemies whom emigrant white-ants have to encounter, for so long as they are on the ground they are exposed to the attacks of a perfect

menagerie of greedy creatures. Civets, musk-rats, toads, bull-frogs, lizards, spiders, and many other animals eagerly devour them, so that in many cases it seems strange that any of them should manage to escape. The scene which is presented at the actual site of emergence is very curious, and in some respects rather disgusting. There is almost always something repulsive in a throng of creeping things, and in this case there is nothing in the characters of the insects to neutralise the disagreeable impression, for their bodies are unpleasantly maggot-like, and their wings, although really delicately netted, are so large and stiff and so awkwardly and feebly attached as to have an aimlessly struggling action, which only contributes to the general idea of the presence of a seething mass of life. The individual insects come hurrying and struggling upwards through all the cracks in the soil leading to the labyrinth of caverns beneath, and, owing to the difficulty which they find in rising into the air, crowd upon one another in steadily gathering multitude, until the earth and grass is often covered to a depth of several inches by a layer of writhing bodies and fluttering wings. A curious dry, rustling sound is caused by the concussion of innumerable stiff wings, and a light cloud of feebly flapping creatures steams off into the air.

The varied interests attending the appearance of swarms in the open air often more than atone for any unpleasant features in the event ; but where it occurs close to a house, and more especially when it comes off after the lamps have been lit in the



late dusk, the results are apt to be almost wholly disagreeable. It is with mingled feelings of rage and disgust that any one who has quietly settled down to read or write suddenly awakes to the fact that his immediate environment has been invaded by hosts of flying creatures, who crowd around the lamps, and falling down on every chair and table race wildly about over them, struggling to shake off their unwieldy wings, rushing over the surface of papers, falling in heaps into any open ink-bottle, and every now and then alighting on his head or hands to go wriggling down his back or up his sleeves. Then it is that the value of intimacy with house-geckos is fully appreciated, for, should any of them have come to regard a writing-table as a safe and convenient hunting-ground, it is not long before they are aware of the windfall, and come hurrying out of their hiding-places to partake of the unctuous feast provided by the lavish supply of struggling insects. Then, too, is a time at which the services of spiders are very welcome, and when their wonderful energy and pluck are most satisfactorily demonstrated by the way in which almost ludicrously small ones will tackle and dispose of such lumbering and loathsome prey.

The destructive inroads of white-ants may occasion curses, and their behaviour whilst swarming may excite disgust; but the cup of loathing for them can only be filled up by means of digging out one of their fastnesses and exhuming the queen of the colony from its secret recesses. She is a truly revolting object, like a bloated, semi-transparent, yellowish maggot as large as a human finger, and

the knowledge that she is practically a huge bag of eggs is enough to remove all wonder at the size of her subject-family.

Certain small relatives of dragon-flies and white-ants, in the form of insects of the family Psocidæ, are often to be met with in Indian gardens, but they are such little creatures as very readily to escape notice, unless in cases where they habitually go about in great droves. The originally smooth surfaces which are left on the stems of many palm-trees by the fall of successive crops of leaves are usually quickly clothed in a coating of crustaceous lichens, painted on in intricate patterns of softly blended colours, and forming a pasture-ground on which many different sorts of small insects browse happily. The lichen-clad stems of *Oreodoxas*, and specially those of *Oreodoxa regia*, are almost always infested by troops of small Psocidæ of a very beautiful species with long antennæ, great, transparent, shining wings banded in grey and black, and bodies whose prevailing tint of vermilion forms a pleasing contrast with the cooler hues of the surrounding lichens. Individually the insects are so small, only a few lines in length, that it is only their persistently gregarious habit that renders them conspicuous, but they travel about in such densely packed crowds as to form well-defined patches of bright colour on the surface of the stems. Such patches are originally of very small size, and contain only a very few insects; but they grow rapidly and, in favourable circumstances, soon come to have diameters of several inches in extent. Even very small groups, however, are conspicuous because

they generally consist in greater part of immature insects in which the bright red hue of the body is not yet veiled by the presence of overlapping wings. The larger groups include numbers of immature specimens associated with fully developed winged ones, who make their appearance in constantly increasing ratio as time goes on. This process, if continued long enough, would, of course, ultimately lead to the formation of groups containing mature insects only; but it is seldom that the transformation is completely carried out, owing to the fact that it is very apt to be arrested by the incidence of destructive epidemic disease.

Any surface, like that of a palm-stem, covered by a continuous rough coating of lichens, forms a site in which fungal spores of the most varied nature may readily lodge and meet with conditions favouring their germination. Among those which are lying in wait on the stems of *Oreodoxas* are the spores of a fungus which has become adapted to play the rôle of a parasite within the bodies of insects, and specially in those of the *Psocidæ* whose habits have just been described. Whilst any infected insects retain life they show little outward sign of disease, beyond a certain degree of sluggishness and a gradual swelling of their bodies; but after they have died the closely packed web of mycelium within them sends out innumerable radiant threads, which break out upon the surface and clothe it in a thick, white layer of conidial cells, or spores, as they are often termed. It is easy enough to demonstrate the contagiousness of the disease, as in order to do so it is only

necessary to transfer one or two corpses from an infected colony to the middle of another group in which no symptoms of disease are present. The immediate result is a general dispersion of the healthy insects, but they very soon come crowding in again to their old place, and begin greedily sucking up the fluids which exuded from the bodies of their dead relatives when these were pressed against the surface of the stem in order to cause them to adhere to it. Within the course of the next twenty-four hours the site of inoculation is sure to be surrounded by a ring of dead insects with swollen bodies and widely spread wings, and on the following day hardly any surviving members of the colony are to be met with. The habit which they have of crowding closely together in seeming indifference to the life or death of their immediate neighbours, and their cannibal feasts on the juices of corpses, must, of course, render these insects an ideal nidus for the rapid spread of any contagious disease; and the materials for infection are always present in profusion in the neighbourhood of any dead one, as, at the time when death takes place, the interior of the body is crammed with fungal elements which almost immediately break out and cover the surface with innumerable reproductive cells.

The successive waves of epidemic disease take place so often and are so virulent that it seems strange that fresh generations of insects should continue to furnish fields for their devastations. It is probable that it is only because the growth of the parasites is so long confined to the interior of



the bodies of their victims that the host-organisms are not wholly exterminated. Once the fungal elements have broken out upon the surfaces of the bodies of a few dead insects in a group, infection runs a very rapid course; but before this has taken place many individuals may have had time to lay eggs, which, as the colony is constantly on the move, may often be deposited in uninfected sites and so form the nucleus of fresh generations. Such epidemics naturally give rise to very considerable fluctuations in the numbers of the insects which are to be met with at different times. The successive waves of prevalence follow one another very rapidly in the case of creatures who multiply and develop with such rapidity, but they probably throw some light on the curious temporal variations in prevalence occurring in the case of certain higher animals in the same region. Any prolonged experience of gardens in Calcutta is sure to teach that there are times in which palm-squirrels and mole-rats are excessively and annoyingly abundant, that these are succeeded by a season in which they suddenly become exceedingly scarce, and that then a course of years sets in during which they go on steadily multiplying until they become as troublesome as ever.

The peculiarly gregarious habits of these insects are as hard to account for as those of some of the smaller kinds of millipedes. The nature of the surfaces which they inhabit, and the fact that they are constantly migrating from place to place, seem to render it very improbable that close

association can be of any appreciable advantage in so far as the acquisition of food is concerned, and, as we have just seen, it certainly has the inherent evil of favouring the spread of epidemic disease. It is possible that the insects possess some property which renders them distasteful to birds and other predaceous creatures, and that by crowding together in large companies they advertise this more efficiently than they could were they to wander about alone. Had it not been for the peculiar colouring of their bodies and the brilliantly reflective radiance of their great glassy wings, it might have been assumed that the gregarious habit served a protective end in causing each group to simulate a patch of the lichens which clothe their ordinary environments ; but, as things are, this can hardly be the case, for, whilst individual insects might well escape notice owing to their small size and gentle movements, colonies of them only stand out more and more conspicuously as they increase in size.

## CHAPTER VIII

### CRICKETS, GRASSHOPPERS, MANTISES, ETC.

. . . like a ghostly cricket, creaking where a house was burned.

BROWNING.

There was a little house-cricket, called *mantis*, which was considered to have this power of the eye over all other animals, and Peisistratus is said to have hung one of them up in the Acropolis as an amulet against fascination.

W. W. STORY.

Fancy the crickets, each one in his house,  
Looking out, wondering at the world.

BROWNING.

ON some still and muggy evening in the end of August or beginning of September, when existence in "the fog and filthy air" which prevails in the intervals between brief and violent thunder-showers has come to seem a burden almost too heavy to be borne, a sound of keen thrilling—a shrill whirring of peculiarly vibrant quality—suddenly arises to announce the fact that the great autumnal crickets have entered upon their annual period of activity above ground. Just at first, the attendant feeling is one of joy and gratitude; for the sound is an unequivocal evidence of the revolution of the seasons, and, like the sight of kites beginning the annual repairs of their nests, announces that the end of the rainy season is approaching, and that within a comparatively brief period cool

breezes and dryer air will set in. But, as evening follows evening without any other signs of progress towards that "divine event," whilst a continuous increase in the numbers of its harbingers takes place, the question arises whether the pleasures of hope are worth the candle of the concerts which go on augmenting in volume until they come to be regarded as evils which must be endured, but most certainly cannot be enjoyed.

To the mind of a gardener, too, the strenuous urgency of the music is unpleasantly suggestive of baleful possibilities; for there is no saying what favourite plants may not have their roots ruthlessly cut as the musicians drive their tunnels upwards, or their tender shoots buried under the great mounds of earth cast out of the openings of the caverns. It is fortunate indeed that these musical performances only last for a limited time every evening, and are not, like so many public entertainments in the British Islands, spread out over many successive hours. Nothing short of actual auditory experience can serve to give any just idea of the horrors of the din; no amount of use to the hubbub of frogs, cicadas, and common crickets which fills the air of nights in moist tropical regions, can lead to an indifferent tolerance for such a screeching, thrilling, ear-splitting, nerve-rending clamour. When in full force it is enough to upset the balance of the soundest nervous apparatus, and to people of irritable temperament it makes for madness. Many people must recollect how one highly placed political officer was so much tried by the sound that, during the season of its prevalence, a Government servant



was specially told off to the evening task of perambulating the garden armed with a kettle of boiling water to be discharged into the caverns of the enemy. Such a drastic method of treatment is of course immediately fatal to the musicians ; but should it be desired to secure them alive, it is only necessary to replace the boiling fluid by cold water ; for a full and continued stream of this when directed into an inhabited tunnel very soon brings the outraged owner struggling up out of it.

How often have the sounds of these concerts been hailed with joy on their onset, listened to with interest as they grew in strength night after night, cursed when at their maximum, and blessed for their decline ! After years spent in a climate of "samples" like that of this country, it becomes hard to sympathise with a longing after winter unless as a season during which the uneasiness of uncertainty may be safely exchanged for philosophical endurance of inevitable evil ; but probably a single renewed experience of the outrages of September in Calcutta would serve to account for the existence of such a frame of mind. Months of continuous dry and, worse than that, of continuous damp heat have followed one another in tedious iteration, and then there comes a dim sense of divine change in the quality of the light at sunrise and sunset, a subtle golden radiance that cannot fail to be adored, but which at first has an almost painful incongruity with the persistent sluggish heat, and excites a feeling of unrest such as it may be imagined moves migratory birds to prepare for their periodic travels ; and to have

this sense of weary longing accentuated every successive evening by the tyranny of a monotonously screeching din is indeed to have the last straw added to the burden of life. The doleful creaking of the wheels of Persian wells, the *sakieh* of Upper Egypt, is usually regarded as one of the particular curses of the hot weather in many parts of India, but the outrage in that case is of a monotonous and not of an acutely irritant character, and from the very fact that it goes on ceaselessly all day and night there is at all events a chance that use may lead to toleration ; but this can hardly be the case with these concerts of crickets which burst out explosively and die off almost as suddenly every evening during the course of many weeks.

During the time that the din is at its worst it is almost as trying to the nerves as that of a pious Buddhist saying his prayers. More than thirty years ago I spent a memorable night in the interior of Sikkim, in a Lepcha house, where sleep was for long rendered hopeless by the devotions of the grandfather of the family, who, being no longer fit for any other work, was seemingly told off to conduct domestic worship, and who certainly bore no resemblance to the celebrated "Daddy Longlegs" of the nursery-rhyme, as in place of showing any disinclination to "say his prayers," he was only too ready to say them too long and too loudly. Hardly had all the lights been put out, and the rest of the household settled down for the night, than the old gentleman uplifted his voice in a way to "murder sleep" and rend the hearts and ears of all unused

to his ministrations. His exercises consisted in endless repetitions of the famous Buddhist invocation "Om mani padme Hung," and his chief aim seemed to be to recite it as often as might be within the term of a single respiration. Each set of repetitions began slowly and solemnly with distinct articulation and pauses between the individual syllables, but as breath gradually failed the pace increased and utterance became indistinct, until the sounds were merely whispered "Ommanipeminies, winding up eventually in a deep, gasping inspiration and, alas! a fresh start in fully restored vigour. Again and again, in the brief pauses in the hubbub, a faint hope that the performer might have burst began to dawn, but, almost before it had had time to vent itself in a sigh of relief over the supposed deliverance, he would be off again in full swing, and it was only after what seemed a perfect eternity of endurance that permanent silence set in. The sounds in themselves were perhaps not quite so irritating as those attending a concert of crickets, but they were rendered particularly trying by the late hour at which they occurred.

In the presence of any inevitable evil the wisest course is to try to acquire some benefit from it, and in this case there can be no doubt that much sport may be derived from a study of the manners and customs of the offensive musicians. Just as the bellowing concerts of bull-frogs herald the onset of the rainy season, the shrill screaming of the crickets foretell its approaching close. During all the time when the rainfall is most continuous there

is no sign of their presence, for they then lie snugly and deeply buried in the soil awaiting a season when it may be safe to open their tunnels on the surface without risk of having them constantly silted up by the inwash of earth from the mounds cast out of their doorways. It is not until the season for the occurrence of brief deluges alternating with periods of brilliant sunshine has arrived that they begin to make their appearance, so that their advent takes place simultaneously with that of the inflorescence of the great grasses which every autumn cover all the low-lying waste land with shining plumes of silver and violet. It is usually in the very end of August or the beginning of September that any of them have so far completed and opened up their fortresses as to have any leisure for music; but should the weather be at all favourable, the choir is very quickly recruited, and within a short time is in full force. Everything, however, depends on the nature of the weather during the time in which the burrows are being opened out and whilst the earth heaped up about their gateways still retains its originally loose and incoherent texture. Should a regular "break in the rains"—a period of several successive days and nights with little or no rainfall—occur, the work of excavation goes on gaily and the concerts are soon fully developed. But should really continuous and heavy rain set in, the work is brought to a standstill, and those musicians who have already begun to sing are reduced to silence; probably finding that for the time being, in place of having any leisure for concerts, they must do



much of their digging over again owing to the fact that all the outer parts of their tunnels have been thoroughly plugged by mud.

It is not very easy to form a clear idea of the course followed in the construction of the caverns, which when completed are of considerable length and follow a peculiar course. Starting from the entrance they descend obliquely for some distance, then turn abruptly and, following a sloping and often slightly twisted course, terminate in a widened *cul de sac*, which forms a chamber within which the owner can turn round, a feat which is quite impossible in any other part of the excavation. One cave, which I carefully dug out, was sixteen inches in length, six being contributed by the outer limb and ten by the inner one and terminal chamber. The angle where the two limbs met lay at a depth of five inches beneath the surface of the ground, and the chamber six inches lower down. I am not certain whether such caves are annually excavated throughout their entire length, but, from the fact that the insects sometimes appear on the surface at abnormal times of year and under the influence of peculiar conditions of weather, it appears probable that in some cases at least the deeper portions form permanent fastnesses in which the owners lie hidden away awaiting the advent of climatic conditions favouring their activity. I have never seen a cricket, whilst at liberty, begin to dig on the surface of the soil, and indeed they are hardly ever to be seen until after attention has been directed to their presence by the shrill screaming which announces the completion of their

labours, or by the molehill-like heaps of loose earth cast out of the mouths of almost finished diggings. Two curious points deserve notice: all the burrows seem to belong to male insects, and emergence appears to be determined, not so much by the recurrence of periodical breeding-seasons as by the incidence of certain climatic conditions; for should a spell of weather like that normal to the statutory season for emergence set in, as it sometimes does, at a different time of year, the event is the signal for the opening up of caverns and the singing of their inmates. In April 1877, and again in the course of a spring many years later, an abnormal prevalence of abundant heavy rain and persistent damp was attended by the appearance of such numbers of crickets that the air thrilled every evening with their screaming just as it normally does in autumn. They would seem to be ready to appear whenever the soil is neither baked so hard by persistent drought as to make digging impossible, or so much swamped by excessive rainfall as to render it hard to keep the mouths of tunnels open.

It is easy enough to observe the methods of working employed in tunnels which have already opened on the surface, and also to study the events attending attempts at the construction of new ones by captive insects. The greatest caution is called for in any attempts to watch the completion of caverns in the open, for the slightest movement on the part of the observer is sure to cause an immediate arrest of work and the precipitate retreat of the labourer to the deeper parts of his

subterraneous habitation. Patient stillness will, however, be rewarded, and it will be seen that every now and then a load of loose earth is pushed up along the upper part of the tunnel, and finally emerges upon the surface followed by the hind-quarters of the miner. Each load is at first left lying just clear of the opening from which it has been ejected, whilst the worker darts swiftly downwards into the depths below ; but, should no cause for alarm be given, he soon comes out head-first in order to shove it farther away and add it to the growing mound of *débris* which has already been cast up. After this a renewed retreat, followed by a pause devoted to fresh digging, occurs, and then another discharge takes place. The mounds of loose earth which are thus gradually thrown up are of considerable size, often measuring four inches in height and ten inches in basal diameter, so that they closely resemble those marking the burrows of common mole-rats. They are very unsightly objects on the surface of carefully tended lawns, and are often sadly injurious in borders containing low-growing plants or newly transplanted seedlings. Unfortunately, the horticultural scathe connected with their formation is not necessarily limited to such injuries, for even more serious mischief is often caused by the ruthless destruction of roots which may lie in the line of the tunnels beneath. Whilst the work of excavation is still in progress the openings of the mines are usually carefully closed with loose earth all day, and are only reopened when the evening brings round the time for renewed work ; but after it has been

finished the door stands permanently open save when it has been accidentally closed by materials washed down into it by heavy, flooding falls of rain.

In order to learn how the work of digging is actually carried on it is necessary to capture some crickets and observe them when shut up on some earth containing no ready-made caves. If prisoners, obtained by means of flooding their fastnesses with water, be placed in a glass chamber like a small aquarium half filled with loose earth, they will very soon begin to dig. After a short time, spent in vaguely wandering round in quest of their houses, they appear to become possessed by devils of energy and go to work furiously. The loose texture of the earth and the overcrowding of the area are very apt to interfere seriously with the conduct of business, but much information may be obtained and many amusing episodes witnessed in watching its progress. The energy and strength which are shown are quite amazing, and the rapidity with which mounds of earth are thrown up, as the workers tear out great clods with their powerful jaws and shovel them about with their flat heads and strong hind-legs, must have been seen in order to be imagined. Individual insects may often be seen hauling about lumps of earth much larger than their heads with apparent ease over the rough and incoherent surface. Whilst digging, they make some use of their fore-legs, but the main part of the work is carried out by means of their jaws, with which they fiercely tear out masses of the soil. Whenever a quantity of loose rubble has



been got together it is pushed backwards by the sturdy hind-legs until the heap becomes inconveniently large, and then the worker turns round and shovels it aside with his head. Even when seemingly most absorbed in work they are so ready for a fray that violent quarrels are constantly taking place owing to neighbouring miners throwing earth into one another's trenches. So long as such insults arise casually and as the result of mere reckless work, they are often only resented by violent stridulations; but now and then a depraved individual, too lazy to face the toil of digging for himself, will try to appropriate the cave of one of his more diligent neighbours and finds his intrusion greeted first by indignant buzzing and then by a series of violent kicks. Where the coveted cavern has been so far completed that the owner has retired to rest in it, the invader has a great advantage, as he no longer has to dread being kicked out and is able to assail his enemy's head, which is now directed outwards. A savage biting-match follows, whilst the invaded insect buzzes loudly and at the same time tries to close his door with earth. After a little time the invader usually tires of the siege and wanders off to assault other diggers who have not yet completed their fortresses. In this case, however, judgment is likely to fall upon him, for under such conditions he possesses no special advantage of position. The outraged insect soon leaves off working and, with loud and furious buzzing, backs out of his cave in order to go in for a strenuous bout of kicking. The opponents approach one another stern on, and kick as hard as

they know until one or other of them is sent flying heels over head to a considerable distance.

Insects of such habits must certainly effect very considerable rearrangements of the soil of any area in which they abound ; for during their periods of activity they bring up masses of earth from a considerable depth and deposit them in heaps on the surface of the ground in a condition favouring speedy diffusion by any heavy falls of rain ; and, just at the times when the soil is riddled by tunnels and covered by the débris thrown out of them, the climatic conditions are such as to favour the occurrence of torrential showers.

It has already been mentioned that the easiest method of securing specimens of these crickets is to drown them out by means of directing a full and strong stream of water along the course of their tunnels, but there is a much more sporting way of capturing them in which skill and patience is called for and a proportionate harvest of interest and amusement reaped. In spite of the fact that, after emerging from their fastnesses, they invariably turn right round so as to face their doorways before beginning to sing, there is small chance of effecting a successful attack from the rear, for they are so acutely sensitive to the slightest sounds or vibrations in the neighbourhood, and so ready to bolt into their tunnels on the faintest alarm, that it is almost impossible to take them unawares. It is, therefore, necessary to approach them from the other side, and, having taken up a position immediately behind the opening of a cavern and its overhanging mound of earth, to maintain absolute immobility until

the inhabitant has had time to recover from the alarm caused by the sound of nearing footsteps and takes heart to venture out and renew his music. On looking downwards over the edge of the door you presently become aware that a great brown head has been thrust out of it, waving a pair of vigilant antennæ, and cautiously examining the neighbourhood. Even when it seems quite impossible that there should have been any just cause for alarm, the insect very seldom comes out at once, and it is usually only after a succession of alternating wary advances and precipitate retreats that he plucks up courage to do so. At last, however, he fairly emerges, and having, as he imagines, secured his retreat by turning right round so as to face his door, begins to sing. In doing so he suddenly raises his wing-covers and seemingly unfolds his wings; but in the dim light of deepening dusk it is impossible to follow his actions in detail, and all that can be actually seen is an appearance of something thrown into such rapid vibration as to simulate a thin bluish haze, from which a thrilling scream issues. Now is the time for prompt and decisive action in thrusting down the edge of a spade or the point of a stick so as to plug the tunnel near its entrance. The slightest delay is fatal, as it inevitably leads either to the escape of the insect into the deeper recesses of his den, or to his death or mutilation during the course of his retreat. When the business has been properly carried out, he makes repeated and futile efforts to get home, returning again and again in a bewildered and blundering fashion to his obstructed

doorway, and then begins to stray about dejectedly in quest of some new asylum. There is now no difficulty in securing him, as his movements are slow and awkward, and the only things to be warded off are scratches from his spiny legs and bites from his strong jaws.

As a rule crickets of this kind do not begin to call until the dusk of late evening has set in, but now and then the deep gloom preceding a sudden and violent thunderstorm will lure some of them out to begin to sing during the day and so blow off some of the nervous energy which has been stored up since the cessation of their previous concerts. It is often the last opportunity which they will have for some time of displaying their musical powers, as for several days afterwards they will probably be fully occupied in clearing the entrances of their houses from heaps of mud and other *débris* washed into them by the impending deluge. Their regular evening concerts only last for a few hours, and it is lucky indeed that this should be the case; for had they been carried on all through the course of the muggy, breathless nights which occur simultaneously with them, hardly any nervous apparatus could have endured the strain with impunity. As it is, a couple of hours sees the worst of the din over, and a little later the night is once more given over to the wonted and ceaseless whirr of smaller insects and the crackling and bubbling conversations of the frogs and toads in the ponds. They are, moreover, only in full force for a few weeks in September and the early half of October, and then begin to diminish in intensity until they finally die



out almost as abruptly as they set in. When they are fairly over the mouths of the caverns are very soon filled up by débris carried into them by wind and rain, and in a short time the only things left to record them are numerous mounds of earth which continue to dot the surface of the soil until they too are gradually weathered down and vanish.

The ways of many other kinds of crickets and grasshoppers common in Indian gardens are well worthy of study. There is one strange little creature who inhabits the grass on the banks of ponds, and when alarmed makes direct for the water, leaps into it, and sinking to the bottom remains quietly seated there until he deems it safe to walk up and take another airing. Great mole-cricketts abound, and every now and then one of them will be tempted by the lamps to come flying into a room at night. They are amazingly powerful creatures, and the energy with which they use their great jagged paws renders it desirable to be cautious in handling them. It was owing to their efficient use of these formidable weapons that they acquired the name of "Deputy Collectors" in some parts of India; for in native hands they were, and perhaps sometimes still are, used as a means of extorting evidence or securing the payment of dues. When a tax-collector in the course of his rounds came across an individual who affirmed his inability to pay up, he often employed the services of a mole-cricket to determine whether the excuse was a valid one. The insect was shut down under a shallow saucer over the skin of the

defaulter's belly, and the vigour with which it set about digging was such as to be well fitted to induce a compliant frame of mind.

Another terrible kind of wild-fowl is a great green insect who often enters rooms after dark and renders night hideous by the persistent and dementing way in which he advertises his visits. Whilst the proper inmate of the room is quietly reading or writing, and fully prepared for grateful enjoyment of the relative coolness of the air, a loud, abrupt, shrill "chēēp" suddenly breaks the silence, and as suddenly ceases, only to be repeated again and again after regular short pauses. Were the sound continuous it might be endurable, but the constant alternations of periods of stillness and ear-splitting din are quite maddening. Attempts to detect and expel the offender are generally futile, for his voice is highly ventriloquial, and, even when correctly located, any efforts to reduce it to silence only lead to temporary success, and then the intolerable "chēēping" breaks out anew as persistently as ever.

Gardens in the neighbourhood of Calcutta enjoy almost complete exemption from injury by locusts. Flights of these destructive creatures very seldom penetrate far into such moist regions as that of the greater part of Lower Bengal, and when they do so the irruption is seldom in sufficient force to occasion any serious damage. It is, of course, far different in certain other parts of India, as I well remember realising in the autumn of 1872 in the Panjab. Then, on the old road between Ambala and Kalka, the wayside trees were loaded with

voracious pink creatures, like boiled shrimps, who filled the air with the crunching sound of insatiate gnawing and broke off great boughs beneath the burden of their clinging hosts ; while a little later, on looking down from the airy heights of the Simla Hills, we saw all the deep valleys crossed by drifting clouds of wings shining with "the splendour of spears," as the slanting sunshine caught their polished surfaces.

Mantises must surely always be objects for amused wonder to any one new to regions in which they abound ! To enter a room and find it tenanted by a mantis is like walking straight into a fairy-tale. The visitor is of such strangely grotesque aspect, and so fully at home and composed in his bearing, that his host can hardly fail to feel intrusive. Moreover, when he is approached he sits up so erect and gazes so steadily out of his great eyes in critical and somewhat minatory fashion that the old classical warning, *mantis te vidit*, acquires new life. At any time of life they are strange creatures, but half-grown specimens are, if possible, even more quaint in expression and attitudes than their mature relatives. They seem to be well aware of the value of their formidable jaws and savagely spiny fore-legs, and are so ready to resent any interference that it is often a matter of difficulty to turn them out of the house without giving and receiving serious injuries. Fortunately, however, there is little need to desire their absence, as their ways are charmingly amusing and quite inoffensive, except in the event of actual insult or interference. The air of gravely critical superiority

with which they study the doings of their hosts is delightful; even when they are quite at rest the dignity of their demeanour is irresistible, and to see one of them clasping a large grasshopper in its great fore-legs and seriously and devotionally browsing off it is a truly impressive experience. Their amazing powers of ingestion were very effectually demonstrated to me shortly after my first arrival in India. One of my servants, who had even then observed my, probably to him, insane interest in any strange living things, one evening presented me with two large mantises. The hour was late, and so, in place of examining them at once, I imprisoned them both beneath a long tumbler and left them to their own devices until the following morning. Then, however, I was surprised to find that one of them was absent, and that the chamber contained only a single drowsy and crowded-looking insect and some scattered débris of the wings and legs of his former companion, whom, although of nearly equal size to himself, he had slain and devoured during the course of the night without suffering from any evident symptoms of sympathy with the afflicted lady described by Ste. Beuve as being *malheureuse dans son intérieur*.

Many kinds of mantises furnish very striking examples of elaborately evolved protective resemblance to their normal surroundings. This has in some cases been carried out in wonderful detail—as, for instance, in a beautiful species which, although apparently absent in the immediate neighbourhood of Calcutta, is often to be met with in the jungles of Midnapur. In it a number



of phylloid expansions of the body and limbs simulate the delicate and varied colours of the leaves and flowers among which it lies lurking for prey. Even in cases in which the process of adaptation has not been so fully carried out as in this instance, it is often easy to trace evidences of its presence in less degree. During the latter part of winter and the succeeding season of dry heat, when various tints of brown and yellow prevail among the foliage of trees and shrubs, which are then either covered by fading leaves or in the course of unfolding young ones, most of the mantises, stick insects, and arboreal crickets are of like colouring (Plate II.); but when the onset of the rainy season introduces an overpowering prevalence of green tints the insects which are most abundant are no longer yellow or brown, but of various shades of bright green, matching those of their surroundings. The curious ribbed greenish or yellow nests of mantises are often to be found adhering to the stalks of stout grasses or to the twigs of trees or shrubs, and furnish quaintly interesting shows when they discharge their contents of little goggle-eyed monsters to sit about in inquisitive assemblies on their outer walls.

The common "black beetles" of England are certainly most fillingly loathsome, but in certain respects they are hardly such unpleasant commensals as the monstrous cockroaches which infest Indian houses. They, at all events, are not addicted to flying, and they are not provided with the long, vigilant, constantly tremulous antennæ,

the very sight of which in their Asiatic relatives is enough to arouse a sense of shuddering disgust. Moreover, they are not so dreadfully alert and active as Indian cockroaches, who, quite apart from any sentimental objections, must always be specially offensive because of their ruthlessly destructive habits. "Black beetles" to a great degree seem to play the part of mere scavengers who are content to confine their depredations to the débris of human food ; but Indian house cockroaches have a truly catholic taste in respect to diet, and it would be hard to say what they may not occasionally be moved to attack. Leather seems to be regarded with special favour, and should kid gloves or boots with soft uppers be left exposed even for a single night, the chances are that on the following morning they will be found covered by unsightly erosions indicative of the feasts which have been celebrated during the hours of darkness. The covers of books, too, are particularly liable to suffer from their attentions, and this not only when they are clothed in leather, for in many cases cloth-bound volumes are sadly injured. In them the nature of the dye seems to exert much influence in promoting or preventing attack ; for whilst cloth of certain colours enjoys a relative immunity, that of other tints is almost invariably and immediately fallen upon. This is specially the case with cloth of a peculiar shade of umber, which is so alluring that, should a book bound in it arrive from Europe in immaculate condition, and be allowed to lie for a single night unpoisoned in any place to which cockroaches can

gain access, it is sure on the following morning to be covered by an eruption of pallid spots.

During the hours of daylight such great cockroaches lie hidden away in cupboards, in crevices in woodwork, beneath the steps of stairways, or in like shadowy retreats ; but no sooner has the dusk of evening set in and the lamps been lighted than they begin to come furtively out and race to and fro over the floors and furniture, seeking what they may devour, and all the time they do so they are terribly alert and so ready to bolt to the nearest cover that it is no easy matter to destroy them. Even when otherwise quite at rest and seemingly absorbed in feeding, they keep their long slender feelers in ceaseless twiddling motion as delicate receivers of any wireless telegraphic impulses occasioned by the slightest disturbances of the environment, so that the most crafty stalking and decisive action are necessary in order to take them unawares. A charming lady of my acquaintance had a truly surprising aptitude in dealing with them, and I have often seen her, during the course of dinner, suddenly spring up, hastily pluck off one of her slippers, stealthily approach the spot where a cockroach was loitering about, and then, by a sudden deft movement, accomplish the explosive dissolution of the enemy into what seemed to be a mass of Devon-cream mixed with brown shards.

Even when on foot they are assuredly bad enough ; but it is on the comparatively rare occasions when they take to flying that they become truly dreadful. During the greater part of the year the chances of exemption from such

a visitation are considerable; but in the early portion of the rainy season there is no security that any night may not be rendered gruesome by the sudden inroad of hosts of brown monsters, who come hurrying wildly into lighted rooms, to rush hither and thither over the furniture and floors, and who, before alighting, are very apt in their headlong course to dash up against walls and pankhas and fall precipitately down on the persons of their human associates. The sensations attending the progress of a large and prickly insect who falls between a shirt collar and neck, and follows a struggling course along the interspaces between skin and sleeve until he emerges at the wrist, are more readily imagined than described !

I shall never cease to think with joy of an event of this kind which took place nearly thirty years ago. A very old friend, who is now in high place in India, but who was then young and comparatively new to the experiences of Indian life, was spending an evening with me during the dangerous time of year, and, in the course of a game of billiards, expressed very strong views in respect to the nonsense, as he considered it, which was often talked regarding the occurrence of "plagues of insects" in tropical regions. Having had a slightly longer experience than his of the possibilities of the environment, I ventured to suggest that he had better reserve judgment on such matters for the time being; and it is probable that he fully appreciated the wisdom of such counsel even before the end of the game; for, only a little time after it had been given, a perfect storm of huge



flying cockroaches invaded the room, dashing up against the lights and canopy, and racing about over the cloth so as to render play impossible.

With all their faults it must be allowed that cockroaches occasionally subserve useful ends ; they certainly are most efficient scavengers of the débris of food which is almost sure to be left lying about under the careless hands of Indian servants, and they sometimes are very useful constituents in the dietary of captive insectivorous birds and other animals. The only trogon with whom I was ever on intimate terms was for a time an inmate of the Zoological Garden at Alipur ; and, during a period in which grasshoppers were very scarce on account of persistent and excessive drought, it would have been very hard to provide him with sufficient food had it not been for the perennial store of cockroaches which was always at hand. He was doubtless a beautiful and rare bird, but, owing to his peculiar ways, was a somewhat provoking one in an underhanded establishment. There was no use in furnishing him at once with sufficient insects to provide him with a full meal, for he would only take those which were offered to him by hand ; and, moreover, he would not be hurried in his meals, and each successive course had to be carefully considered before it was accepted and deliberately eaten. The only serious objection to the use of cockroaches in such cases lies in the fact that their legs and wing-covers are so hard and resistent in texture as to be apt to be indigestible to birds who are used to somewhat softer food, so that in most cases it is desirable

to pluck them off before administration. Many years before becoming acquainted with the value of cockroaches as food for birds, I had practical experience of the readiness with which toads will devour them. At that time I made daily visits to a dry well in my garden devoted to the conduct of experiments on the temperature of the soil at various depths. The neighbourhood abounded in toads, and some of these, whilst taking shelter beneath the boarded and turfed cover of the pit, often fell into it and remained prisoners. One of the captives became so used to my visits that he was wont to come out of his lurking-place whenever I arrived, and confidently await a supply of food. His appetite was so large that I should have been hard put to it to satisfy its demands had not the servant, who was in attendance to let down and draw up the ladder of access, been a man of resource and well acquainted with the zoology of certain of the recesses in the cook-house. Thanks to this, he was easily able to secure a large handful of huge cockroaches every morning, and hand them over to me to be doled out to the expectant toad. Even to handle a single insect whilst his vigorous struggles send cataracts of cold shudders along the course of the backbone is a task calling for some resolution, but to tackle a whole handful of them would seem to most Europeans a task demanding heroism for its performance.

But cockroaches do more than serve as scavengers and sources of food to other and more attractive animals, for in houses which are much

infested by them it is almost impossible to avoid acquiring a tolerance or even a grateful regard for certain creatures whose presence is apt to be regarded as an unmitigated evil. When muskrats are seen eagerly devouring them, or a great grey spider appears, clasping one to her breast, and greedily sucking up its juices, the evident benefits which they confer in doing so are surely well fitted to do away with any sentimental objections to their company.

However much we may be disposed to regard cockroaches with aversion, their beautiful nests or egg-capsules must always excite admiration. In form they closely resemble a miniature Gladstone-bag with fluted sides of deep brown, shining leather. They are often to be met with adhering to the surfaces of fragments of matting or other débris in obscure corners of rooms, or in the recesses of boxes and cupboards.

## CHAPTER IX

### BUGS, CICADAS, FROG-HOPPERS, APHIDES, SCALE-INSECTS, ETC.

Tush, tush ! fear boys with bugs.

*The Taming of the Shrew.*

In which space, the air growing foggy—swarms of ants, musketoos, flies, and stinking chints, cimices, etc., breed and infest them.

DR. JOHN FRYER, M.D., F.R.S.

*Regarding Mechlapatan.*

As ghastly bug, does greatly them affeare.

*The Faerie Queene.*

INSECTS belonging to the great order Rhynchota abound in all tropical regions, and many and widely differing species of them are only too well known to gardeners in Lower Bengal. Most of them are really inoffensive creatures, unless when present in very great numbers, as they may be at certain times of year, and specially during the course of individual seasons of abnormal character. The last two years which I spent in Calcutta were exceptionally dry and were further distinguished by an unwonted prevalence of some kinds of bugs which throve and multiplied until they became veritable garden-pests. The unusual drought was in itself sufficient to make it a hard task to keep many sorts of plants in good condition, and it was very trying to have



this difficulty enhanced by the presence of hosts of greedy creatures, who hung in masses on the leaves and twigs, and deprived them of the scanty stores of liquid which they had acquired and retained under the adverse climatic conditions. Even where they are doing no serious harm, the mere sight of great masses of such insects is enough to cause disgust and to render the work of dislodging and destroying them highly unpleasant. During the winter of 1896-7 all the branches of a large *Thunbergia*, clothing a plant-house in my garden, were daily coated by dingy brown layers of large bugs, and it required a strong effort of will to approach and disturb the marauders and send them sailing off on great wings which suddenly unfolded into flakes of the brightest vermilion.

The regularity with which the flowering of certain plants is accompanied by the appearance of particular kinds of bugs is very remarkable. Each successive spring when the great pods of the silk-cotton trees come showering down to split and discharge their burdens of white wool, bright orange-red bugs appear in such numbers in attendance on them that it is hard to find a single fruit which is not tenanted by several specimens (Plate VIII.).

European houses in India are nowadays hardly ever infested by the most offensive and familiar member of this group of insects, but the degree to which it abounds in native dwellings in many parts of the country can hardly be imagined, and it remains a mystery why, in the face



PLATE VIII.—FLOWERS OF SILK-COTTON-TREE.



of constant facilities for importation, outsiders should so seldom have any cause to complain of annoyance. It would appear, however, that it is only since houses have been built and furnished specially for them that Europeans have enjoyed this immunity; for in the accounts of experiences in India given by seventeenth-century travellers, the bites of "chints," or "chinces," are often alluded to as sources of great discomfort. A set of ribald verses, purporting to be the utterances of a newly arrived Governor, fresh from Europe and flushed with enthusiasm for the romance of the Orient, used to be familiar to Anglo-Indians. It included the following lines :

Are those the houris underneath yon sheds?  
What *are* they doing to each other's heads?

and if "beds" be substituted for "heads" the couplet would very fairly serve to express the surprise which new-comers must often have experienced on seeing a *charpai* brought out into the road and soundly belaboured by its owner in hope of dislodging its troublesome inmates. I never suffered the slightest injury from them during the whole of a long residence in India, and only on three occasions was their prevalence disagreeably forced upon my notice. On two of them exigencies of travel which necessitated the temporary occupation of *charpais* borrowed from native houses were to blame, and were only attended by the mental agitation following sudden discoveries of unpleasant tenants of articles of clothing, among which a sun-hat enjoyed an



undesirable pre-eminence. On the third occasion an early detection of danger obviated any evil results, but was in itself so startling as to ensure vivid and enduring reminiscence. In the old days when the railway between Madras and Bombay had not been completed, there was a time when the *doab* between the Tungabudra and Kistna rivers had to be crossed in *dàk-gàris* of the vilest quality running over a track of the roughest construction. The mail-train from Madras reached the Tungabudra river in the evening, and a *gàri* awaited the traveller on the farther bank to jolt him slowly along to the Kistna, over which he and his belongings were ferried in an archaic boat shaped like a shallow saucer and built up of strong wicker-work covered by hides. The nature of the road and of the carriages was such as to be almost certain to ensure a sleepless night, and this trial was supplemented by the fact that, when the railway was once more reached, there was neither a station in which to shelter nor even a train to provide accommodation until late in the evening when one came in from Bombay. An enterprising Parsi had, however, rigged up what he called a hotel, in the form of a huge tent erected on the exposed sand of the bed of the river, and advertised food and lodging for wayfarers. At first everything went well; a bath and breakfast of fair quality were quickly disposed of, and then I lay down on a great but somewhat dingy couch with the purpose of making up for the involuntary vigils of the rough travel of the previous night. Whilst I was happily smoking and

enjoying the gradual growth of drowsiness, my attention was fortunately attracted by what seemed to be a strange fault in the pattern of the dirty cretonne cover of my resting-place ; and on closer examination, not only there but in many other places the surface was found to be thickly coated by hordes of loathly brown creatures clustered together so as to form large dull patches of an umber tint. It need hardly be said that instant flight followed the discovery, and the rest of the day was spent in the open air, where, although exposure to a blazing sun was inevitable, there was less chance of contact with such offensive neighbours. The innumerable crevices in the ill-fitting wood-work of native houses and furniture provide endless harbours for insects of such habits, and it is little wonder that in such an environment they are able to defy all attempts at expulsion or extermination.

In the neighbourhood of Calcutta there are none of the great cicadas who render life terrible in certain other parts of India, and specially in heavily wooded, hilly regions, by their maddening music ; but at particular times of year their minute relatives, the so-called “green flies” or “green bugs,” are present as veritable plagues. It ought indeed to be a matter of deep and lasting gratitude in all inhabitants of such an area that true bugs never make their appearance in such exuberant multitudes as these small creatures sometimes do, especially during late autumn and early winter. No one without actual experience of what one of their serious irruptions

means can possibly form any just idea of the thronging myriads in which they suddenly break out. There may have been hardly any signs of their existence for a long time, and even up to the very afternoon of the day on which a visitation is about to occur nothing to warn one of its approach; but then, often before the dusk has deepened enough to render the street lamps conspicuous, the air suddenly becomes thick with winged swarms, crowding around the wayside lights and thronging into houses in drifting mists. The quantities of insects who immolate themselves around the street lamps is often so great that whole bucket-loads of corpses have to be swept up and removed from the neighbouring ground on the following morning; whilst, within lighted rooms, life is for the time being rendered almost unbearable by their reckless flight and sharply stinging bites. I once attended a dinner in honour of a distinguished officer in the Royal Engineers which was well-nigh rendered abortive owing to coincidence with the occurrence of a specially abundant swarm. Nothing had occurred to give any warning of misadventure; "but, Lord!" as Mr. Samuel Pepys would have said, on entering the club where the feast was to be held, the air was found to be everywhere foggy with insects, whilst dense clouds of them shaded all the lamps and fell in pattering showers on the floors below. The public rooms were mainly lighted by means of old-fashioned gas "sun-lights," in which circles of jets burned above a huge saucer of translucent glass, and the accumulations of roasted corpses

within these receptacles very soon became so great as to threaten to tear them down. This danger, and the really insufferable annoyance arising from the crowds of flying insects, were enough to lead to a general extinction of all lights save those which were absolutely necessary, and the dinner was conducted in deep gloom, faintly illuminated by the twinkling lights of scattered candles, which had been hastily rummaged out and stuck into the necks of empty bottles.

When a swarm invades any place in which fresh coats of paint have just been laid on, the results are disastrous; for every moist, adhesive surface forms a trap which is quickly sprinkled by clinging corpses, each of which leaves a permanent scar behind it when brushed off. The distribution of the irruptions is often very curiously and sharply defined, certain streets being infested at a time when others at a very short distance from them are practically exempt. The street in which I latterly lived in Calcutta was a very quiet and unfrequented one, and during the course of sixteen years' residence in it I never knew it to suffer from a serious invasion. I have often driven home-wards through streets in which the air was thick with insects, and have thankfully observed their numbers diminishing as the main thoroughfares were left behind, until in the neighbourhood of my own house there were hardly any to be seen. The distribution of “ green-flies ” in Calcutta seems to show that their favourite hatching-grounds, like those of common house-flies, are in places within which the soil is highly contaminated by materials



derived from horse-droppings, and consequently that the most efficient means of putting a stop to the occurrence of swarms must lie in efficient sanitation of the streets. This was certainly much neglected in Calcutta during a long period of years ; and with this, annual plagues of "green-flies" recurred regularly in all the main thoroughfares of horse-traffic.

Many species of aphides occur in Indian gardens, but, in so far as my experience goes, they are hardly so troublesome as those which must be contended with in European ones. Some of them, as has already been mentioned, are specially interesting on account of the attractions which they present to various species of ants, who carefully tend them for the sake of the sweet secretions which they yield, and who, in certain cases, build up elaborate protective structures around their colonies. The curious cow-houses which are erected by the common yellow tree-ants on mahogany trees afford striking examples of these, and many other instances of a like nature are constantly to be met with in large gardens containing trees and shrubs subject to the attacks of aphides. The presence of the latter is very often conspicuously advertised by an unsightly blackening of foliage which is not directly caused by the injuries inflicted by the insects, but arises from the fact that their secretion of honey-dew provides a soil congenial to certain species of black-moulds, which soon cover the affected surfaces with dense webs of deep brown mycelial filaments.

Scale-insects are far more likely to be sources of

grave trouble to an Indian gardener than aphides. They often cause great injury to many different plants, and seem specially disposed to attack such as are grown in pots. This fact comes out very clearly in regard to plants of *Codiaeum*, commonly known as Crotons; for, whilst specimens grown in the open garden are rarely and only slightly attacked, those which are so often used to decorate the verandahs of houses are usually greatly infested, probably because they are less frequently visited by insectivorous birds. Although often giving rise to serious mischief, scale-insects are usually by no means so offensive in appearance as aphides; and, indeed, one of the horny, limpet-like shells into which the bodies of the mature females are ultimately transformed is a really lovely object when turned over so as to expose the masses of delicate little eggs which fill its concavity. Scale-insects of many different kinds abound in India; as almost every one knows, gum-lac and lac-dye are the indirect and direct products of one species; and in the good old days before coffee-planters had to deal with the devastations of any formidable blights of fungal origin they used to regard the so-called "coffee bug" as running a good second to the "borer," both because of its directly depletory effects on the vigour of the shrubs and on account of the prevalence of black and suffocating mildews attending the stores of honey-dew with which it covered the surfaces of the affected leaves and twigs.

However great the sins of Lower Bengal may be,

there is at least this to be said for it that the local conditions do not favour the presence of those truly abominable creatures, fish-insects, in the exuberant numbers in which they are to be met with in many other parts of India, and specially in some of the hill stations. There are, however, always enough and to spare of them in Calcutta, so that on turning out any accumulation of papers which have been laid aside for some time without previous poisoning, it will generally be found alive with them and very often bearing conspicuous evidences of their destructive activity. They are often said to limit their ravages to the linings of the boards of books and other papers which have been freely sized in order to keep them in place ; but this is by no means universally true, and files of loose sheets of paper often suffer very severely. At the same time, they certainly have a decided preference for thickly sized surfaces, partly owing to the nutritive qualities of the adhesive medium, but also because the sites in which this is to be found provide conditions of obscurity congenial to their furtive habits. It is probably owing to this that they abound so excessively in hill stations in which the walls of rooms are often papered in place of being merely white- or colour-washed, as they usually are in houses in the plains.

They are strangely repulsive objects ; for, though they really have a beautiful silvery lustre, their furtively scuttling movements and the curious filaments at the ends of their bodies excite an unpleasantly creeping sensation. Moreover, a very brief acquaintance with them is almost inevitably

fraught with memories of the results of their devastations and of the gruesome fashion in which they "softly and silently vanish away" into greasy shining smears on being crushed, so that it is hard to regard them with dispassionate interest. They are so wonderfully fragile that it seems curious that they should be able to play havoc among such seemingly resistant substances as paper or dry gum and starch-paste ; but their ravages are so formidable that it becomes absolutely necessary to have recourse to special protective measures in order to secure any valuable books or papers from them. Here, again, corrosive sublimate turns up trumps ; for the slightest traces of it introduced into the size of wall-papers, or washed over the surfaces of books or documents, are enough to ensure an almost certain and lasting exemption.



## CHAPTER X

### CENTIPEDES, MILLIPEDES, SCORPIONS, SPIDERS, ETC.

But it is one of those queer things  
Whose cause is all unknown—  
(Such are the wasp, the household fly,  
The shapes that crawl and curl  
By most called centipedes).

*Fly Leaves.*

See me tap with a hoe on the plaster  
Till out there shall fall  
A scorpion with wide angry nippers.

BROWNING.

She therefore looked again and said, "Here is nothing but an ugly spider, who hangs by her hands upon the wall."

*The Pilgrim's Progress.*

THERE are surely few creatures so repulsive as large centipedes ; scorpions certainly have their bad points, but they are neither so revolting nor so formidable. They are, luckily, comparatively rare near Calcutta, and hardly ever enter European houses even in the suburbs. Every now and then, however, one of them appears as an unwelcome guest in the outhouses occupied by servants. A short time before I left India, a *chaprasi*, glorious in the scarlet and gold of the offices of the Government of India, entered my laboratory one forenoon leading a huge centipede, like a little dog, tethered by a string tied round its middle. It was a gruesome offering to my taste for curios as it

wriggled wildly about in vain efforts to lay hold on something with its hooked claws and great sickle-like jaws, and I was glad to house it as quickly as possible in a bottle of spirit. In spite of its forbidding aspect and unpleasant size (Plate II.)<sup>1</sup>—it was seven and a half inches long and of proportionate girth—it was impossible not to admire the richness of its colouring, the ochre of its under surfaces, the rich brown of the great scales of the back, the livid brown madder of the sides, and the bright coral-red of the multitudinous legs, each of which was tipped with a cruel almost black claw. I was never attacked by one of these terrible creatures, but it is easy to imagine the sickening horror of the sensation which must arise when the cruel jaws and long series of hooked claws are simultaneously buried in the skin; and I was told by a friend that he had never seen such an expression of abject terror as that exhibited by a man who was taken unawares by such an assault.

Millipedes of various kinds are constantly to be seen in Indian gardens, and often occasion groundless alarm in people who recognise their superficial likeness to centipedes, but are quite ignorant of their wholly inoffensive nature. In going along the course of gravelled paths in the early morning before the sunshine has absorbed the dew of the previous night, attention is often attracted to the presence of certain strange slowly moving patches of purplish red on the ground; and,

<sup>1</sup> The figure shows the size of the creature, but unhappily the drawing was not made until after immersion in formalin had faded and altered its colouring.

on closer examination, these are resolved into great herds of small millipedes, closely packed together, and browsing their way along over the surface. Now and then certain individuals of the throng will find some specially alluring pasture and be seduced into lingering behind their companions; but no sooner have the dainties been disposed of than the loiterers hurry eagerly on to rejoin the troop. A gregarious habit so firmly established as this one is must certainly have been evolved because it provides some advantage in the struggle for existence, and, as it does not seem likely that the acquisition of food can be rendered any easier by it, it is probable that it is of some protective value, either from alarm produced by the appearance of a relatively large moving body or as a conspicuous advertisement of the presence of some distasteful properties in the creatures which build it up.

Millipedes of far larger size are common, but they are never to be met with in great companies. Specimens of one splendid species are often to be seen wandering about over the stems of trees and browsing on the layers of bright yellow and silvery grey lichens which clothe the surface and form a background of pleasingly contrasted colours. They are often as much as three or four inches in length, and are beautifully decorated by alternating bands of two shades of gold, fringed by long rows of innumerable brown-madder legs along which waves of movement run with every forward or backward movement of the body. In another and even handsomer species which sometimes appears in the rooms of houses, the

ground-colour of the body is deep red, and crossed by blackish brown bands. In any of the larger forms it is easy to note that, when the creature is travelling, the legs come into play in groups of four or six at a time, so as to give rise to a series of waves along the sides of the body in such a fashion that as many as five undulations may be simultaneously present on either hand. The phenomena of movement certainly seem to indicate the presence of a chain of more or less independent nervous centres, each of which is immediately related to a separate group of limbs. Many large millipedes when coiled up present striking resemblances to slenderly whorled snail-shells, especially in those cases where there are longitudinal pale bands along the sides, or where the legs are of a different tint from the body.

Scorpions are very rare in the immediate neighbourhood of Calcutta; and those which now and then appear are hardly ever natives of the place, but involuntary immigrants who have been imported along with wood or other materials coming from regions in which they abound. They are essentially creatures of dry places, and naturally do not find a congenial environment within the limits of the great swampy area of the lower Gangetic delta. Those which are imported are generally little grey creatures like those which haunt the walls of rooms in many other parts of India; and the black monsters, resembling diabolical prawns, who lurk among the stones of dry hilly regions, are hardly ever to be seen unless when they have been wilfully introduced. It is ordinarily



believed that the stings of the small grey species are more formidable than those of the great black ones, but I do not know on what evidence the idea rests, and have no personal experience in regard to the effects of either. The only occasion on which I ever had any experimental dealings with scorpions was at a time when special inquiry was carried on at the Zoological Garden in Calcutta in regard to the action of snake-venoms and reputed remedies for their effects. Any reputed instance of individual immunity to the action of venoms was naturally of interest in connection with work of this nature, and so, when it was reported that a *yogi* in the Mirzapur district was famed for his insusceptibility to the stings of scorpions, it seemed to be quite worth while to incur the expense of importing him to Calcutta. The accounts of his endowments appeared to be so well authenticated as to leave little room for doubt in respect to their existence, but at the same time a suspicion remained that the animals which he used in his performances had been tampered with so as to interfere with the efficiency of their powers of stinging. On the offer of what seemed to him very handsome remuneration, the man agreed to come down to Calcutta, and presently made his appearance, and was quartered in the Garden. He arrived, bringing a number of scorpions with him, and, until he had become used to the place and duly conscious of its potential pecuniary advantages, he was allowed to use them in the course of his exhibitions. Meantime, however, a number of large, freshly

caught black scorpions were imported from Midnapur, where they abound, and were carefully secluded in a place to which he could have no access had he known of their presence and wished to tamper with them. In due course he was invited into the laboratory where they were confined, and was asked to give a private exhibition with them. It cannot be affirmed that he greeted the proposal with alacrity—indeed, he seemed to be decidedly unwilling to comply with it; but on being reminded of his repeated assertions of immunity and of the existence of a yet unpaid pecuniary reward, he screwed his courage to the sticking point. The result of this was to show that he really was from one or other cause practically insusceptible to the action of the virus; for he allowed several large, lively scorpions to fix their stings so firmly into his fingers that, when he raised and shook his hand about, they remained anchored and dangling by their tails, whilst neither then nor afterwards did he show the slightest signs of pain or inconvenience. This, to any one who knows how acute the pain caused by the stings of scorpions normally is, was conclusive evidence of some peculiar endowment; the evidence of at least relative immunity was complete, but the question of its origin remained undetermined. The uneducated natives to whom the exhibition was ordinarily made naturally regarded the outcome as the result of *yog*, or supernatural power, acquired as the result of penitential religious rites, but to an unprejudiced observer two more materialistic explanations presented themselves. The

immunity may possibly have been the result of innate idiosyncratic peculiarity in the constitution of the performer, or, more probably, represented the outcome of artificial exemption acquired at the expense of repeated inoculations with the virus and corresponding development of its antitoxin. Modern experiments have shown how easy it is to establish a relative and cumulative immunity to the action of snake-venoms by means of their repeated inoculation, beginning with sublethal doses and gradually working upwards from them; and a more homely example of like nature must be familiar to all who have ever lived for long in a region infested by mosquitoes. All who have done so must remember the amount of discomfort attending introduction to the environment, and how, in the course of years, and after the occurrence of innumerable inoculations, mosquitoes would have been regarded with contemptuous indifference had it not been for their persistently irritating humming notes. There can, I think, be little doubt that our friend the *yogi* had undergone a very considerable amount of suffering in order to acquire his reputedly miraculous endowment, but this may well have been made good by a just appreciation of the material benefits likely to accrue from its possession.

Few people are likely to hanker after keeping scorpions as prisoners—they can hardly be styled pets—but any one with such depraved tastes who has tried the experiment will readily allow that they are most diverting creatures in the quaintness of their attitudes and the deftness



with which they secure and sting flies and other insects presented to them. It is always well, however, in undertaking to domesticate them to be aware that the pain caused by their stings is most effectively treated by ipecacuanha powder, ammonia, the freshly cut surface of an onion, or some lime scraped from the nearest white-washed wall.

English gardens often contain multitudes of spiders, but the numbers present in them are never to be compared, either as regards species or individuals, to those which are to be met with in tropical regions in which the climate is damp enough to secure the presence of perennial supplies of insect-food. In the gardens of Lower Bengal they abound at any time of year; but it is during the autumnal months—in the latter part of the rainy season and the beginning of the cold weather—when insects are still present in excessive numbers, and when the delicate fabrics of webs are no longer exposed to continual risks of rupture by torrential falls of rain, that they become particularly conspicuous. At this time all the lawns are every morning thickly bespangled by silvery patches of brilliant radiance marking the sites occupied by closely meshed nets laden with moisture; all the shrubs and trees bear multiform fabrics, waving gently in the breezes and “laughing with lucid dew-drops rainbow edged”; and, across the whole breadth of the roads and paths, monstrous webs, reminiscent of the magical one of *Potentilla* in *Phantasmion*, are extended overhead between the boughs on either side. The variety in the types of webs, in their sizes, textures, and plans, is quite



bewildering. Strange and dingy little creatures, like "water-boatmen," set rudimentary snares amid the miniature jungles of aquatic vegetation on the margins and surfaces of the ponds; green, white, or peach-coloured specks, no bigger than large pin-heads, hang in the midst of delicate tracteries of the finest threads among the foliage of all the shrubs; and huge monsters, clad in black and gold, sway to and fro in malignant vigilance on cordage hanging vertically from the branches of the trees. The numbers and varieties of gins are so great that it seems strange that any flying insects should escape capture; and, as though this were not enough, nomadic tribes of leaping garotters are for ever wandering about over the foliage and prying in eager quest among the fallen leaves beneath.

Some webs are wonderfully elaborate in structure. One beautiful black and yellow spider weaves a fabric consisting of a delicate vertical net with four radiating, zigzagged strands of coarser texture passing outwards for some distance from points near the centre. When the owner is at home she sits in the very middle of the net with her legs closely gathered into four pairs and extended along the conspicuous lines of the thick strands, so that, as long as she remains at rest, her body looks exactly like a mere local thickening of the fabric. In this instance the concealment evidently subserves the purpose of facilitating the capture of prey, but in others it seems to be mainly protective in function. There is a very common, long-legged spider who spins a great, tenuous web in shady corners. In the centre of this she sits motionless

until alarmed or disturbed, and then at once begins to sway about on her slender legs so rapidly and vigorously that her body becomes a mere indistinct streak and the web disappears from view during its swift vibrations; conditions which must tend either to alarm or deceive predatory creatures, such as wasps, large dragon-flies, or the birds who are constantly on the outlook for spiders and their webs as sources of food and materials for nests.

The wonderfully elaborate mimicry of various kinds of insects which is so often to be met with among spiders may in some cases serve a protective purpose, but in very many instances it is probably devoted to predatory ends. The mimicry which has caused one species to simulate such a savagely stinging creature as the black and brown ant, *Sina rufonigra*, both in form and colouring, may fairly be taken as being of purely protective value, and the strange resemblance of another, inhabiting the rafts of floating vegetation on the surface of ponds, to water-boatmen may possibly be of both protective and predatory benefit; but there are many other cases in which protection can hardly have come into play to determine the strangely elaborate modifications of form and colouring which now prevail. Examples of such predaceous mimicry are to be met with both among web-spinners and the forms who depend on their individual craft and agility to ensure the capture of prey. There is one rarely beautiful little creature who, when she sits quietly in the centre of her small web, presents the appearance of a moth with wings

painted in white and pale umber because of the presence of strange dorsal expansions, which spread out on either side whilst she is at rest and completely hide her head and closely tucked-in legs. But, whenever she begins to move about, the shields fold down along the line of a transverse ridge and reveal her rounded body, head, and limbs. Another spider, who dispenses altogether with a web, lies in wait for her prey among the ripening seed-capsules of various kinds of plants, where her fat buff and ochre body accurately simulates its surroundings; and in another case it is a slender twig or small stick-insect which has served as the model for a strange little being with slender reddish yellow body, eyes seated on long stalks, and extremely long legs which when their owner is at rest are gathered up into four bundles pointing directly fore and aft. Whilst there are many cases in which spiders seem to mimic vegetable structures, there are some in which the relation seems to be reversed; when a plant of the *Aristolochia* represented in Plate IX. is in full flower, it looks at a little distance as though it were infested by a host of large brightly coloured spiders.

The effects produced by slanting sunshine on the threads and nets of spiders are often rarely beautiful. When long, separate threads hang down over the course of paths over-arched by boughs through the interspaces of which the light streams down in isolated shafts, they go on softly swaying to and fro in the gentle currents of air, and, as they vary in inclination so as to take or lose the rays, silvery lines go wandering up and down over





PLATE IX.—FLOWERS OF AN ARISTOLOCHIA, LIKE LARGE SPIDERS.





them in mysterious radiance. Where the giant webs of great spiders face oblique sunshine they become transfigured into nets of shining gold; and perhaps the most lovely shows of all are those which are presented by the delicate snares of some of the smaller species when laden with innumerable glittering drops of dew in the early morning. Among the most beautiful of webs in such circumstances are those belonging to a very common gregarious species, whose elaborate structures often fill whole shrubs with their intricate labyrinths.

Each web consists of a tent of closely interwoven threads, supported and extended by a complicated system of slender ropes spread out around it in wide meshes, and forming a secluded shelter beneath which the owner sits to watch for prey and keep guard over her row of silken egg-cases suspended in the cordage overhead. The shrubs in which colonies of such webs are to be found are almost always provided with hard, resistant, acutely pointed leaves, affording special facilities for the support of such complex structures as the nets are, and Agaves and Jacquinias seem to be regarded as specially desirable sites. Owing to the extreme fineness of the individual threads, the webs, even when present in almost countless numbers and closely crowded together, are almost invisible during the greater part of the day; but in the early morning, and whilst still drenched in dew, they shine out like fairy encampments, glittering with innumerable points of light.

The gigantic black and yellow spiders, who come out every autumn to hang their great webs among

the branches of trees and shrubs, are of malignly superb aspect. Speaking roughly, their nets may be described as hanging vertically, but in reality they are always slightly inclined to one or other side—an arrangement which, whether purposive or not in origin, is unequivocally of very considerable benefit to the owners. That this is the case may be very readily proved by means of a simple experiment. If a dead leaf or light twig be thrown on to one of the webs so as to adhere to it, the proprietor at once rushes out towards it from the centre of the net in hope that the disturbance announces the advent and capture of prey; but, whenever she discovers what the true state of matters is, she forthwith proceeds to get rid of the foreign body by means of cutting away the part of her snare in which it is entangled. Now it is clear that, had the web hung truly vertical, any portions detached from it, unless they originally formed portions of the lower margin, must have been apt to slip downwards and give rise to new entanglements, whereas, so long as the surfaces are inclined, they are likely to fall clear, leaving cleanly cut spaces which can readily be filled up by new threads. Such nets as these are of very considerable strength, as may often be unpleasantly demonstrated to any one passing heedlessly along a path over which one of them has been stretched. So strong, indeed, are they that even relatively powerful and vigorous birds may be taken captive by them—not that they ever remain hung up in the snares in their original position, but because, in tearing their way through, they carry away such

masses of cordage closely wrapped around them as to render further flight impossible. The commonest of the great webs in gardens in Calcutta are tenanted by two very distinct kinds of spiders. In one case the owner of the net is a very large creature clad throughout in deep velvety-black, whilst in the other she is of smaller size and dressed in black, orange, and pale yellow. In the former variety the legs often spread out over areas of four or five inches in diameter. The clear spaces above paths over which the nets are hung are often so wide that it is not easy to imagine how the first threads can have been extended from the branches on either side. In the case of the webs of very small spiders the difficulty may be supposed to be overcome by vigorous leaping and subsequent floating in gossamer fashion on emitted threads; but this can hardly occur in the case of such bulky, heavy creatures as these are.

Although true trap-door spiders are to be found a little farther south, in Orissa, I have never seen any of them in the immediate neighbourhood of Calcutta. The small spiders who constantly spread dense little webs over the surfaces of lawns, and other open grassy spaces, have, however, in certain respects very nearly acquired the right to be regarded as members of the class. The texture of their threads is so delicate that their webs, although really containing several layers of network, are almost invisible when dry, and only stand out conspicuously in the early morning when loaded with burdens of dew. A tube, bounded by walls of closely interwoven threads, opens above



upon the surface of each web, and is continued downwards through all the layers of net below to end in a subterranean tunnel. In this fastness the owner, a small, umber-brown, agile creature, lies in wait and ready to rush upwards whenever her net is shaken by the struggles of a snared insect. The dew which illuminates the webs is usually evenly distributed in minute points, but sometimes it collects in hollows in the nets into great, jewel-like drops, shining with silvery radiance owing to the thin films of air separating them from the scaffolding of threads beneath, over which they slide to and fro, like globules of mercury, whenever their support is shaken. Many other kinds of small, dingy spiders inhabit cracks or tunnels in the ground, but do not take the trouble to connect them with snares of web; and now and then larger ones will appropriate the remains of caverns formerly tenanted by great autumnal crickets, and may be seen sitting watchfully at the doors of their dens ready to rush out on any heedless prey or, in event of the slightest alarm, to dive into the gloomy depths of their fastnesses.

Among the most conspicuous of common spiders are the great, grey, hairy, long-legged creatures who are so often to be seen sitting about on the walls of bathrooms. They are certainly well fitted to inspire awe and apprehension in the mind of any defenceless bather owing to the motionless malignity of their aspect when at rest, and to the astonishing and uncanny speed with which they can dart about, apparently with equal ease in every direction, on being roused from their

baleful meditations. The best way of getting rid of such unwelcome visitors is to throw water at them from a safe distance; but there is really no good ground for molesting them, as they are most inoffensive in spite of their forbidding looks. They have their good points too, and a very brief acquaintance with them is usually enough to show that they are very useful neighbours. I always regarded them with respectful consideration after seeing one tackle a great cockroach. The monster was flying and running about the room, and in the course of its "alarms and excursions" bolted up the leg of a chair and proposed to ensconce itself beneath the covering of the seat. The choice of locality was, however, unfortunate, as a large spider was already in possession, and promptly arrested the intruder, seizing it by the throat and pinning it back-downwards against the wooden frame of the chair, until its frantic and ineffectual struggles gradually died out under the influence of a series of venomous bites. On another occasion I found my bathroom tenanted by a huge spider who was clasping a monstrous cockroach to her bosom whilst she sucked vigorously at the corpse. How long the feast had been in progress I do not know, but it certainly lasted for about four hours more, and when it was ended left very little of the victim behind, save the hard, resistant tissues of the wings and legs.

In ordinary circumstances these large spiders spend no time in weaving; but, when about to lay, they manufacture curious flat, round cases of dense grey tissue in order to hold their eggs. At such

times they may often be seen carrying these nurseries about with them. When the young spiders are hatched they continue to inhabit their birthplace for some time, and should this be detached from the body of the mother it is very interesting to see the way in which multitudes of minute creatures swarm out of it, and quite pathetic to note the anxiety and distress of the bereaved parent until she has regained her treasure.

Spiders of this kind are so constantly met with in rooms that they very soon cease to attract notice, but now and then strangers of great size and alarming mien make casual incursions from neighbouring gardens. One which frequently looked in on me at my laboratory was a giant with brown, yellow-spotted legs spreading out over four inches and a half, and a body, over an inch in length and half an inch broad, clothed in long reddish hairs.

It is only the largest spiders who are fit to tackle such huge and athletic creatures as big cockroaches, but many of the smaller ones are true benefactors in the way in which they help to clear houses from other kinds of noxious insects. A vagrant white ant, whilst laboriously flapping about over my writing-table, found out this to its undoing. It came into contact with a delicate little web, which a beautiful miniature spider had extended over the opening of one of the compartments in an empty letter-rack, and remained anchored by its large, unwieldy wings. For a time its violent struggles to free itself by shaking them off prevented the spider from getting close enough to bite, so that



it seemed doubtful whether the adventure would not end in the ruin of the net. The captor, however, showed herself quite fit to rise to the occasion, and again and again came up to fix new threads to the fluttering wings, and then draw them tightly out and attach them to the original fabric of the snare. At length a stage arrived when she thought it safe to make a sudden rush in and inflict a vicious bite on her victim, and after this the end came very quickly, as, under the influence of the venom, the previously violent struggles slackened, and in a very short time were only represented by fitful and convulsive movements of the legs.

Whilst spiders are usually quite inoffensive to their human neighbours, exceptional cases do turn up in which they are guilty of vicious and unprovoked assaults upon them. Once while seated quietly and, in so far as I was aware, quite inoffensively at work at a table, I was suddenly aware of a violent stinging pain in one of my legs, and, on looking down, saw a hideous, squat, brown spider firmly fastened to the skin and seemingly bent on having a square meal at my expense; indeed, so fully had she settled down to the feast that it was only after being treated to a deluge of rectified spirit that she was prevailed upon to let go.

The spiders who normally inhabit the jungles of aquatic weeds fringing the margins and spreading out over the surfaces of ponds have been specially modified to meet the conditions of their environment. Besides those which have already been alluded to as mimicking water-boatmen, numbers



of fat greenish creatures, almost invisible among the surrounding vegetation, wander quietly round and rush out over the open spaces of water in order to secure any heedless insects which may have fallen into them ; while large grey ones haunt the floating rafts of *Limnanthemum*, and on the slightest alarm hastily retreat beneath them, forcing their way in between the under surfaces of the leaves and the supporting water.

Considering how savage and voracious spiders usually are, it seems curious that they ever should display socialistic tendencies, but in some cases large numbers of them are to be met with as tenants of the same shrub, and seemingly in very fairly peaceable relations with one another. In the neighbourhood of Calcutta the great black-and-yellow autumnal spiders are always of solitary and morose habit ; but in the Valley of Nipal the same or some very closely allied species lives in great colonies established in intricate mazes of webs spreading over and throughout whole shrubs or small trees. So, too, in the case of the small tent-building spiders of Calcutta, isolated webs are very rare, and as a rule multitudes of their beautiful fabrics are found closely packed together within a small space. In such cases, however, the question remains open how far the congregations represent the outcome of any truly social instinct, for they may quite well have arisen merely as the result of individualism benefiting by the increased facilities for the capture of prey attending the presence of a number of closely associated snares. Each web in the aggregate may really represent

an independent estate, whose confines may not be trespassed upon with impunity; but there are other instances in which the association seems to be truly communal. During the latter part of winter, when the foliage is at its thinnest, numbers of large balls of dead leaves and twigs, bound together by a dense fabric of tough webbing, and permeated, like sponges, by an intricate system of tunnels, are constantly to be seen on many trees and shrubs. They are constructed and occupied by hosts of short-legged, dull grey spiders, who come swarming out of the mouths of the tunnels whenever their houses are disturbed, and who are certainly truly social in their habit of feasting peaceably in company on the bodies of insects who may have been ensnared in their webs. When these colonies are first established, many of the leaves entangled in the netting are often quite green and fresh; but within a very short time, and whilst all the unentangled ones around retain their vitality, they wither and dry up just as those utilised by tailor-birds for their nests and by ants in the formation of shelters for aphides usually do. The death of the leaves in all these cases is probably owing to suffocation of the tissues caused by the inclusion of the great respiratory surfaces within enclosed spaces, and the obstruction of the stomatic orifices by webbing or other foreign bodies. The great masses of web which are heaped up in such colonies are perfect treasuries to ioras, bulbuls, kingcrows, and other birds who use such materials freely in building, and, at those times of year when nesting is in full swing, the trees containing them are

constantly visited by eager birds hurrying in to carry off large bundles of spoil.

Where the owners do not clear them as promptly of foreign bodies as the great autumnal spiders do, webs often become heavily laden with miscellaneous débris, and may present a very curious appearance. I was once much astonished by seeing what at a little distance seemed to be a firefly or other luminous insect giving out intermittent flashes of light at midday in the deep shade of a dense group of trees ; but, on going closer, I found that the appearance was caused by a fading yellow leaf spinning round at the end of a long strand of web, and every now and then presenting its surfaces to stray rays of sunshine which filtered through interspaces in the overhanging screen of foliage.

Most jumping spiders are wonderfully agile and fearless—arachnidan Japanese—taking boldly off from the edges of tables, to light with an audible slap on the floor, and forthwith hurry away “at a great, padding pace” worthy of the lion in the Valley of the Shadow of Death. The extreme variety and often striking beauty of the colouring in them and other spiders is wonderful. In some garden spiders the prevailing tints are of protectively tender shades of leaf-green ; some are dressed in ochre or bright yellow, so as to resemble fading leaves or ripening fruits ; others are pure white or delicate pink ; and in still other cases the body seems to be clothed in a layer of grey velvet laced with lines of silver.

Most Indian gardeners must be only too well acquainted with various forms of disease in plants

arising from the presence of different kinds of spinning mites. Their attacks often give rise to such conspicuous malformations of leaves as seriously to injure the appearance of shrubs and trees. Such diseases are frequently ascribed to the action of fungal blights; but they are generally characterised by the presence of a feature which serves at once to show their true nature. Specimens of such deformed leaves were often sent to me with inquiries regarding the nature of the fungus causing the mischief; but in most cases the work of determining the true cause of the complaint was very simple, as cursory examination with a simple lens so often showed that the affected tissues were covered by an abnormal growth of hairs. In very many cases the irritation of the leaves caused by the punctures of mites leads not only to general hypertrophy, but to a special overgrowth and multiplication of hairs which often cover the injured surfaces with continuous coats. Why the punctures of mites should lead to this special form of nutritive reaction remains as mysterious a problem as that which presents itself in connection with the strangely multiform development of gall growths following the punctures of vegetable tissues by various kinds of insects.



## CHAPTER XI

### CRABS, SNAILS, EARTHWORMS, AND LEECHES

Am strong myself compared to yonder crabs.

BROWNING.

The tender horns of cockled snails.

*Love's Labour Lost.*

Snail, a slimy creeping insect.

SKEAT'S *Etymological Dictionary.*

The worms crept out,

And the worms crept in.

*The Lady all Skin and Bone.*

SMALL crabs inhabit almost every pool of fairly clean water, and are frequently to be met with wandering about over garden walks. In gardens abutting on the river the steps of the ghâts leading down to the water are at certain times of year almost sure to be invaded by hosts of immature crabs—minute, pinkish, semi-transparent creatures, many of whom become the prey of the predatory ants who are ceaselessly roaming about, and who greedily seize and carry them off to their citadels. Now and then, too, strange visitors in the form of king-crabs wander in from the river, and are to be found in the courses of ditches opening into it; they are uncanny and somewhat repulsive objects.

I have no personal experience of the degree in which snails may afflict other parts of India; but

I do know that the ravages committed in gardens in Calcutta by the members of a Brobdignagian species, originally imported from Mauritius, are very often just grounds for cursing. They have unfortunately found the local conditions all too congenial, and have thriven and multiplied proportionately. The magnificent size and rich colouring of their shells must always command respectful admiration, but their exuberant numbers and quite appalling appetites are sorely trying. I have known one equal to the task of devastating the whole crown of a great *Crinum* in the course of a single night, just when the plant was promising to bloom superbly, and the injuries which they are perpetually inflicting on other plants are conducted on a like scale. But their great size is offensive not only in this respect, but it also renders the work of destroying them extremely unpleasant. To crush a common British garden-snail is not a very alluring task, but to do the like in the case of one of these monsters is infinitely more disagreeable, and demands true moral courage for its efficient performance. As the outcome of prolonged experience, I can strongly recommend the use of a stout walking-stick as the means by which the work can be accomplished with a minimum of injury to the feelings of the executioner; for, under the influence of its sudden and forcible administration, not only is disruption satisfactorily achieved, but the unpleasant results are driven away to a seemly distance. The smaller kinds of snails who inhabit gardens in Calcutta seldom do any serious mischief, and are sometimes well worthy

of study, especially some of them who abound on the stems and branches of mango-trees and do not appear to have been able to make up their minds whether to be slugs or snails, as they are only provided with delicate, glassy little shells far too small to house more than a very small part of their bodies. All the ponds contain many different kinds of molluscs, and at certain times of year their banks are almost sure to be ornamented by little heaps of the beautiful white eggs of a large water-snail, deposited in small hollows carefully scooped out in the soil on purpose to receive them.

Earthworms of most pernicious activity infest every garden in Lower Bengal. Even in European gardens they often evoke curses for the havoc which they play on lawns, but no experiences of temperate regions, and not even the fullest Darwinian faith in their efficacy in promoting the formation of beds of humus can lead to practical toleration of the results which they can achieve in congenial tropical regions. Every successive morning during the damper times of year, the surface of each treasured lawn, no matter how carefully tended and frequently rolled it may be, is sure to be so thickly covered by castings that it would be hard to find a spot on which a foot could be set down without crushing several of them. And such castings ! no mere humble mounds like decorated miniature mole-hills, but towering edifices rising vertically into the air in intricate convolutions to a height of several inches and with a girth of corresponding proportion. Under such conditions no

amount of scientific appreciation of the ultimate benefit arising from their labours will suffice to suppress a desire to conflict with the architects, and fortunately several very simple methods of doing so are always at hand. Among the most efficient of these are free irrigation of the soil with solutions which, whilst perfectly harmless to grass, are profoundly poisonous to worms. The native gardeners, or many of them at least, are well acquainted with a vegetable infusion—the essential constituent in which is, I believe, a kind of water-weed—which possesses such toxic property ; but, in default of it, weak solutions of blue-stone are always available and highly satisfactory. When a suitable occasion presents itself—when the soil is soft and permeable, but not saturated by recent deluges—if the surface of a lawn be freely sprinkled with one of these solutions it is not long before hosts of worms begin to writhe up out of their caverns and struggle feebly about in various stages of intoxication. Many of them speedily die, but others pull themselves together again after a time, so that it is always well to gather up and garner the harvest without delay. The numbers which can be collected are quite amazing, and in many cases a small lawn will yield enough to fill several large buckets. A like phenomenon may sometimes be seen in gardens in the west of England where the waste from arsenic works is used as gravel, and I have seen the walks of a garden in Devon almost as thickly strewn with poisoned worms as any Indian lawn after being treated with blue-stone. Certain kinds of Indian earthworms are so large that the



tracks which they leave on muddy ground might easily be mistaken for those of small snakes. These gigantic worms are often adorned by brilliantly iridescent greenish bands, which shine out conspicuously on those parts of their bodies which are fully extended during the course of their travels over the surface of the soil.

Leeches are happily comparatively rare in the plains of India, but the long grasses and other rank vegetation, which spring up in the pools of stagnant water occupying hollows during the rainy season, are very often infested by numbers of great, pallid, striped monsters. I never was attacked by them, but my dogs, during our frequent visits to their haunts, used often to suffer and return to the house accompanied by very fine specimens acquired during the course of their explorations of such alluring hunting-grounds. In order fully to realise what leeches can be and do in India, it is necessary to undertake a few marches during moist weather in the forests of the outer ranges of the Eastern Himalaya. I have never done so during the height of the monsoon, but the experiences to be acquired at any time when heavy falls of rain frequently take place are quite filling enough, and I was fully satisfied by those which characterised the initial parts of two trips into the Sikkim hills in the early part of October, when occasional deluges saturated the jungle and converted all the forest tracks into streams of running water. The commonest leeches in these hills are slender brown ones, like bits of dark whipcord when empty, but rapidly "swelling visibly" under the influence of

draughts of blood into glossy black sausages, resembling well-fed garden-slugs. A very brief visit to their domains at a time of year when the local conditions favour their activity will suffice to secure an unpleasant familiarity with their appearance, manners, and customs ; for, should any brief halt be made on the moist and mossy surfaces of the stones marking the line of what is supposed to represent a path, they are almost sure to attract attention as they come eagerly trooping inwards from all quarters and converge upon their prey ; and, unless he have skilfully protected himself, the wayfarer is almost certain to end his day's march bearing a burden of clammy, black vampires, hanging in wreaths around his ankles and occupying scattered outposts all along the course of his legs.

On the second occasion on which I suffered severely from their attentions, experiences of camp-life in the relatively dry hills of Kumaon and the neighbourhood of Simla had led me to forget how troublesome leeches might be in other regions, and to regard sandals as the most comfortable form of foot-gear for hill-work. I accordingly started from Darjiling shod in such fashion, but it did not take long to convince me that I had made a sad mistake in doing so. During the course of the first two marches all went well, for the route followed roads which were wide and well ordered, and the weather was relatively dry. On the following night, however, heavy rain came down and converted the next day's track, which led over the shoulder of a great forest-clad

mountain, into a series of quagmires, alternating with running streams and mossy stones where the levels forbade any accumulation of water. These conditions alone might have been enough to show that sandals were not adapted to meet the demands of the locality; but a farther demonstration of this fact awaited me when, after much laboured plunging and slipping down the farther slope of the hill, I reached camp and discovered that I had imported a whole colony of leeches, who had found a ready highway through thongs of leather and loose woollen stockings to the skin of my feet and ankles. Fortunately they had not been able to push their invasion any higher, owing to the close texture and clinging quality of the *pattis* above, but, as it was, the number of bites which they had inflicted within the areas which they could reach was quite enough to cause much annoyance for some time. The adventure aroused lively reminiscence of much more serious discomfort in the same hills sixteen years earlier, when for a considerable time the beginning of each day's march was rendered miserable by the presence of ulcerated anklets of leech-bites which smarted violently until warmed up by continued friction and which obstinately refused to heal until after I had been for several weeks in the plains.

It is almost impossible to avoid such trouble when a large number of bites have been inflicted on a limited surface of skin. The greatest care may be taken to avoid irritating the intolerably itching area, but the skin is so much weakened



that it is ready to give way under the least provocation, and, where the ankles are the site of injury, this is almost sure to occur sooner or later during the course of marches over rude tracks in a rocky and precipitous country. The slightest casual slip may occasion an abrasion ; and when once a raw surface has been established, nothing short of absolute and prolonged rest, which is usually out of the question during camp-life, will serve to bring about a cure. “ Jamais ! ô jamais plus,” as the refrain of one of Madame Tastu’s doleful little poems has it, is there much chance of my finding myself again in those “ delectable mountains,” but were I ever to do so I should certainly pin my faith to the use of waterproof “ K ” boots and stout Pindi *pattis* as a defence against leech-bites. Common shooting-boots, in so far as my experience goes, afford a very imperfect protection ; for, however strong and carefully secured they may be, the more adventurous and persevering members of the foe either travel upwards to the tops or work their way through the crevices of the flaps and lace-holes. But there would seem to be something repulsive to leeches in the leather of waterproof “ K ” boots. When a traveller, shod in them, stands on a moist, mossy block of stone in one of the trickling streamlets, which in remote parts of Sikkim represent paths during the rainy season, he very soon sees myriads of leeches hastening out of the surrounding jungle and working their way towards him from all directions ; but no sooner have they arrived at their goal than they suddenly pause



and, after a few futile efforts to overcome their disgust, give up the attack and sulkily retire to their lairs. During the course of the tour which has already been alluded to, the weather remained very wet for five successive days after that in which the use of sandals had turned out so badly—rain came down in torrents every afternoon to convert all the tracks into running streams; but by the help of “K” boots and strong *pattis* the marches were accomplished without any further inconvenience, and, in so far as I can remember, without the reception of a single additional bite. It is only after travel under such conditions that the value of boots like these can be justly appreciated; it is only after experience of them, not only as armour of proof against leeches, but as foot-gear which never becomes saturated with water and therefore is never rendered hard or brittle by unskilled processes of drying, that the measure of respect for their virtues is equitably filled up.

Leeches are relatively rare in the comparatively dry hills of the North-western Himalaya, but even there they are sometimes unpleasantly numerous and may give rise to untoward experiences. A friend of mine, in coming down from Masuri to Dehra, managed to allow two leeches to establish themselves on his palate whilst he was unwarily drinking directly from a wayside stream, in place of using his hand or a straw as a medium of supply, and I once met a boy who was even more seriously afflicted as the result of like rashness. Every one who has travelled over relatively un-

beaten tracks in the interior of the Himalaya is aware that one of the daily trials of a weary wayfarer on arriving in camp is to be beset by natives possessed by an unreasoning faith in the wisdom of Europeans, and specially in their skill in the treatment of disease. On our way from Simla to Chini, a friend and I arrived one forenoon at the somewhat rudimentary dak-bungalow at Urni, high up on the slopes of the valley of the Satlej. We were both rather done up, as the march had been a fairly stiff one, up continuous slopes, baking in the blazing sunshine of a day in May and quite devoid of rocks or trees to furnish any efficient shade; so that on reaching our destination we should have been glad to rest in passive admiration of the glorious view up a long reach of the valley, with the river raving and shining far below, and wooded slopes on either hand converging towards the magnificent snows of the Ralding Hills.

But fate had decreed that the rumour of our approach should precede us, and an eager patient await our arrival in the verandah with urgent demands for immediate advice and treatment. He was a lad about fifteen years old, and affirmed that he had for some time been the unwilling host of a leech, which had managed to establish itself in his nose whilst he was drinking from a streamlet. As my companion was, like myself, a member of the Indian Medical Service, I at first tried to make over the case to him, on the plea that he knew rather more of ordinary practice than I did. He, however, obstinately declined to listen

to the voice of the charmer, and so, as the patient continued his clamours for treatment, I said: "Very well; as you won't do anything of an expert nature, I'll try what common sense can effect." The patient was made to lie down flat on his back on the floor of the verandah, and a teaspoonful of good Scottish whisky poured into the nostril which he said was inhabited. As may readily be believed, a furious fit of sneezing followed, and before it was over a very handsomely proportioned leech was expelled from its comfortable quarters. The joy of its host was great, and it was a most filling sight to see the air of triumph with which, and a profuse shower of salaams, he bore off the corpse of his tormentor, laid in state upon a leaf for the admiration of his friends. He was a truly grateful patient too; for when a few weeks later we again visited Urni on our outward march, he awaited our arrival on the steps of the verandah in order to renew his salutations. The people of that part of the country, though like most natives of the hills sadly neglectful of personal hygiene, seem to be possessed of a keen sense of gratitude. Only a few days later we were suddenly greeted with rapturous shouts of recognition from a dear little dirty boy about three years old, who was accompanying his parents and their goats to the high-level pastures, and to whom I had given a four-anna bit some weeks earlier when we passed the party on our inward journey. Lavish gratitude for trifling benefits is well fitted to make the heart of its recipient somewhat sore!

The lives of most terrestrial animals must at certain times of year be rendered almost intolerable within the area infested by leeches in the Eastern Himalaya. Dogs and horses are constantly liable to have their nasal cavities attacked, and it is gruesome to see the unhappy cows, who graze in open spaces in the forests, raise their heads out of the rank vegetation and show muzzles wreathed with masses of gorged black monsters. Even terrestrial birds must suffer greatly, and the relative rarity of deer and almost total absence of pheasants throughout the zone of elevation within which leeches most abound are probably the outcome of a very real struggle for existence.





PART II

THE SEASONS IN A BENGAL  
GARDEN









SOME ORNAMENTS OF INDIAN GARDENS.

- Fig. 1. Flower of Semal, *Bombax malabaricum*.  
 „ 2. Large central stamens of the same flower.  
 „ 3. Small stamens  
 „ 4. A female fruit of *Ficus Roxburghii* before access of insects: natural size.  
 „ 5. Part of a gall-fruit of the same fig, showing the tunnel bored by the male insects through the plug of bracts which closes the cavity: natural size.  
 „ 6. Fading leaf of Country Almond, *Terminalia Catappa*:  $\frac{1}{4}$  natural size.

## CHAPTER XII

### SPRING AND SUMMER IN AN INDIAN GARDEN

He casteth forth his ice like morsels.

Ps. cxlvii. 17.

The cuckoo then, on every tree,  
Mocks married men ; . . .

*Love's Labour Lost.*

The day with cloudes was suddeine overcast  
And angry Jove an hideous storm of raine  
Did pour into his leman's lap so fast.

*The Faerie Queene.*

IN winding up a sketch of some of the commoner events of animal life in any particular region it is perhaps not out of place to try to give a general idea of the environment in which they occur—to attempt some description of the stage and properties of the theatre on and amid which the various episodes are enacted—and the following notes regarding the general characters of the seasons of an Indian year have accordingly been put together. They are necessarily and avowedly very imperfect—the greatest literary skill would be hard put to in order to convey any just sense of the charm of actual experience—but even a very feeble record may perchance serve to revive blurred memories in the minds of old Anglo-Indians, and to render the varied attractions of Indian gardens

clearer to those who never have had the privilege of personal acquaintance with them.

The year in Northern India is usually regarded as including only three seasons—the hot weather, the rains, and the cold weather. The first of these corresponds to spring and early summer; the second to late summer and autumn; and the third to winter; but in reality there are periods between them, and specially between the third and first, and the second and third, which possess features almost justifying their recognition as distinct seasons. In any country of such wide area as the Indian peninsula neither the incidence nor the duration of the various seasons can be precisely simultaneous everywhere. In the plains of the extreme south it would be “a terminological inexactitude” to describe any part of the year as being “cold weather,” and the degree to which the term is fairly applicable varies with every advance towards the north. Residents of the United Provinces, and even more those of the Upper Panjab, scorn the so-called cold weather of Lower Bengal; and Calcutta, in its turn, looks down upon Bombay. So in respect to the rainy season; the time of its onset and the amount of water which it brings vary greatly in different areas, so that no description of the climatic events in any particular region can be regarded as strictly applicable to the country at large. Bearing this in mind, it is evident that any account of the characteristic features of the seasons within a special province—within Lower Bengal in the present case—cannot be taken as representative of those

prevailing throughout the whole peninsula, and that many of the statements in the following pages must therefore be regarded as referring only to local conditions and events.

The Hindu solar month Phālgan, corresponding with the latter part of February and the first half of March, may be taken as the beginning of the horticultural year in Lower Bengal, for it is then that a great annual revival of active vegetation replaces the dormancy and decadence attending the continuous drought and relative cold of winter. Dryness normally persists and even increases for a time, but it is not long before sudden, violent storms begin to come up and yield brief deluges of rain; and, even in their absence, the steady rise in temperature is enough to occasion many important changes. In the absence of rainfall, grasses and other shallow-rooting plants may show few signs of renewed activity; but on trees and shrubs the fall of leaves, which has been going on quietly for some time before, takes place much more generally and rapidly, and is very soon accompanied by a sudden outburst of blossom and of fresh foliage which often seems actually to dislodge that which preceded it. The wealth of varied colouring presented by masses of fading and budding leaves and crowded blooms on so many different trees and shrubs is quite astonishing, and the alterations which it undergoes are almost kaleidoscopic in their startling rapidity.

Flowers cover all the mango-trees with yellow tufts contrasting finely with the deep green of the older foliage and the bright bronze of young



spring-shoots ; *Nephelium Longana*, the asphal, is decked in silvery grey plumes ; the warm brown of the ripening pods on the tamarinds shines out amid the olive-green tints of the pillowy masses of finely divided foliage which surround them ; the almost leafless siris-trees, *Albizzia Lebbek*, are thickly clad in broad, pale-ochre fruits which shine up into pallid gold when the sunshine strikes them ; the dāks are still partly brave in crowded red blossoms, but already begin to show the strangely pallid bluish tints of their closely packed pods ; the asokas are mounds of bloom varying in hue from the palest ochre to deep Indian red and vermilion ; yellow leaves come slowly down from all the clumps of bambu with a strange, leisurely, screwing motion, and, at the same time, many of the canes are already gay with small bright green blades ; the country-almonds are in every stage of change, some glowing in well-nigh unimaginable glories of gold, carmine, and deep purple ; others almost leafless, and a certain number already covered with pendant bunches of little white flowers and crowds of tender green young leaves, which hurry out so rapidly that it appears as though they could be seen to grow minute by minute in their haste to restore the magnificently stratified tiers of foliage which glorify the trees during the greater part of the year.

Among the most strikingly decorative trees at this season are the various species of *Sterculia* which clothe their leafless boughs in a wealth of brilliant inflorescence. *Sterculia colorata* breaks out into such profuse bloom that the trees, for the time being, look as though they were made of red coral ;



PLATE XI.—*Sterculia ornata* IN FULL BLOOM.



and *Sterculia ornata* (Plate XI.), which at other times is a somewhat stiff and ungainly object, is temporarily beautified by a robe of long, drooping wreaths of pale ochre corollas and soft purple calyces "whose tender locks do tremble every one at every little breath, that under heaven is blowne" (Plate XII.). The sight of a tree in this state, standing out against a sky of the brightest purest blue, is enough to make even the most unemotional spectator sympathise with the Psalmist who said, "For Thou, Lord, hast made me glad through Thy works, and I will rejoice in giving praise for the operations of Thy hands." The experience is one of those which cause "the water to stand in the eyes" from an almost painful sense of incapacity to appreciate such an intensity of beauty. A little later, one of the great ornaments of the hot weather, the *amaltās*, *Cassia Fistula*, comes into bloom, and, with its shining foliage and bunches of rich yellow flowers, looks like a glorified laburnum. To walk unawares under a tree in full bloom is like walking suddenly into an old-fashioned English garden at the same time of year, so much does the faintly sweet, somewhat rhubarby odour of the flowers recall that of summer-tulips.

The pipals, *Ficus religiosa*, are particularly adorable in spring owing to the wonderful variety of delicate tints which they show. At any time of year their foliage is admirable in the fine outline and shining surface of the leaves which hang so lightly on their long stalks, constantly trembling in the breezes like those of aspens, and tapping one another with their long slender tips so as to



make a sound refreshingly like that of a heavily pattering shower of rain. But, when clothed in young leaves, they have a very special charm, for in some cases the fresh blades are of all shades of tender green, and in others of the brightest rose and purple. An avenue of great pipals in this condition can hardly fail to recall that of the oaks in *The Flower and the Leaf*:

Which wexen forth to meet the sonne's sheen,  
Some very red and some a glad light greene.

And in truth it would be hard to find a gladder green than that of the leaves in this case. Pipals, as well as banyans and many other figs, are strangely idiosyncratic in respect to their times of leafing and fruiting. Hardly two trees in an avenue or group of them seem to agree exactly as to the precisely proper time to change their clothes, and in many cases trees which stand side by side, and seemingly exposed to exactly like conditions, show so little sympathy that one of them will still be covered with fading yellow leaves when its neighbour is already brave in masses of pale green young ones. A perfect caricature of this tendency to individualism used to appear annually in the famous old banyan-tree in the Botanic Garden at Shibpur; for, in it, nearly one-half of the tree used to shed its leaves, flower, and fruit many weeks earlier than the other. It is, of course, open to question how far the individual parts of a large banyan retain any intimate organic relation to one another, but, be that as it may, the whole organism is the outcome of a single seed, and its various parts are necessarily closely related to one another



PLATE XII.—*Sterculia ornata*: A SPRAY OF BLOOM.



locally, so that the presence of such conspicuous differences of habit is very remarkable.

In spring the displays of varied and rich colouring are almost bewildering, and, as though to increase sensory intoxication, the air, and especially the air at night, is so full of odours that in the course of any evening stroll it is easy to realise what Keats meant by “embalmed darkness.” The only pity is that in some cases the spices which are employed are hardly of a quality to appeal to human æsthetics; the air around a maple-leaved *Pterospermum* in full flower is an olfactory paradise, but that near a blooming fetid *Sterculia* is distinctly the reverse !

It is not only in the vegetable world that the stimulant influences of the changing season manifest themselves, for hardly has the temperature begun to rise appreciably before there is a stir among the birds. Many migrants almost at once show signs of preparing to depart, and the permanent residents are not long in beginning to betake themselves to domestic responsibilities and labours. Even at the very outset of spring the crows are fully occupied in nesting, quarrelling over the possession of specially eligible building materials, devastating gardens in quest of them, and becoming even more annoying than usual because they no longer have leisure for any prolonged outings from their headquarters. The koils are only too well aware what their neighbours are about, and day by day the “merry notes” of the male birds ring out with growing insistency; pied cuckoos begin to fly piping overhead; bulbuls



show unequivocal intentions of building; and, as the heat increases, the metallic and monotonous cries of the coppersmith-barbets become more and more continuous and irksome.

The wide range of temperature, like that which recurs in autumn, favours the development of dense nocturnal fogs; for the nights often remain relatively cold long after the sunshine has regained sufficient power to render the days unpleasantly warm. After foggy nights during which the mantle of vapour has not descended to the level of the ground, the surface of the soil in the early morning is often quite dry and dusty save beneath specially aspiring trees, like *Casuarinas*, from the higher parts of which heavy showers of great drops of water come pattering down. On the other hand after a low fog everything is drenched in dew; but, in spite of this and of the generally diffused gloom, a walk along the verdurous country lanes is full of alluring peculiarities. There is a sense of seclusion and mystery—a delightful feeling of being left alone with the trees and the birds—a wonderful softly brooding silence seems to enfold everything, and is only broken by occasional subdued notes, the soft rustle of falling leaves, and the gentle murmur of showers shaken down from masses of soaking foliage stirred by a passing breeze. The path winds on through a series of isolated pictures, quietly coloured and melting off into soft grey gloom; troops of garrulous babblers riot among the moist heaps of fallen leaves; the usually piercing notes of kingfishers have a strangely muffled quality; and crows bathe enthusiastically amid the dripping

tresses of the bambus, which, as the mist thins off under the growing heat, begin to be gilded here and there by slanting sunbeams.

Taken as a whole, spring in a region like Lower Bengal is a really delightful season, even though it may be overshadowed by anticipations of the approaching trials of the hot weather; it replaces the autumn of temperate areas in being the time at which the glories of decadent foliage reach their fullest development, but it has an additional and very special charm in combining these with the effects attending the sudden opening of hosts of young leaves and flowers.

The pity is that it should last for such a short time, for in the course of a very few weeks heat begins to assert itself overpoweringly. The after-glows, which so far have regularly painted the western sky evening by evening in flaming colours, gradually fade and then completely die out; the sky during the day more and more loses its transparent blueness, and, all round the horizon, becomes veiled in dull yellowish haze as the sun blazes on in relentless ferocity. Presently, however, one great alleviation appears, for, when once the change of season has been fairly established, the nights are blessed by the presence of a sea-breeze, which rises at sunset and streams inwards from the Bay of Bengal in cool and gentle persistence all through the hours of darkness. The thermometer day by day goes on rising higher and higher and, when the temperature at noon reaches 90° F. in the shade, the fact that summer has fairly arrived no longer admits of doubt. Temperatures

ranging up to  $85^{\circ}$ , even when accompanied by humidity as high as that which normally prevails in the lower Gangetic delta, are very bearable, and to many people are actually pleasing; but beyond that point the sensation of heat becomes insistent, and the rise of each successive degree above  $90^{\circ}$  causes a very sensible increase in the call for endurance, until at about  $98^{\circ}$  it often seems as though no farther accommodation were possible.

Everything, however, is regulated by the degree of atmospheric humidity which is simultaneously present. So long as the air remains relatively dry all goes well, and in a natural breeze, or an artificial one evoked by a *pankha*, life continues to be very tolerable even after the thermometer affirms a heat of  $98^{\circ}$ ; but whenever a considerable amount of atmospheric humidity is present the struggle for existence becomes burdensome even at lower temperatures. I have often been exposed to temperatures of  $110^{\circ}$  in the dry regions of Upper India, but certainly never felt anything so killingly oppressive as the heat which prevailed in Calcutta in the latter half of June 1878, when the thermometer did not record more than  $98^{\circ}$ . The season was altogether an abnormal one, for an unwonted number of violent thunderstorms in May had yielded ten inches of rain, and delightful coolness for the time being. Indeed we were all disposed to think that "the bitterness of death was past," and to congratulate ourselves on having got through the hot weather as easily as we had done a few years before in the exceptional season of



1871, in which rain occurred almost continuously from March to November. This dream did not, however, last long; for in the beginning of June the storms abruptly ceased to come up, and the onset of the monsoon, in place of occurring in the middle of the month did not come off until the beginning of July. For a time the coolness occasioned by the preceding rainfall persisted; but, as the sun continued to blaze down steadily day after day, and the air became more and more saturated, it gradually diminished, and was replaced by an almost terrifying, stagnant, damp heat. As has already been mentioned, the great diurnal fluctuations in temperature which characterise spring and autumn in Calcutta often lead to the formation of dense fogs, but, except on this occasion, I never knew them to take place in summer. Then, however, there were several mornings, after nights during which the thermometer had remained steadily at  $98^{\circ}$ , in which everything was veiled in a dense white mist which muffled every sound, drenched all the shrubs and grass, and dripped from the tops of all the trees in heavy showers. There was something ominous about the heavy shrouds of vapour which hung around throughout all the earlier hours of the morning and then gradually thinned off to reveal a uniformly hazy and ochreous sky, in which the pallid and sharply defined sun hung and mercilessly added to the already almost intolerable heat. Under such conditions of atmospheric saturation, perfect stillness, and a temperature which never fell below  $98^{\circ}$  F. at any hour of day or night, there



was no period of natural respite, and no means of acquiring any artificial one ; for the pankhas, however energetically they were plied, only served to stir the hot moist air without giving rise to any appreciable evaporation. Whilst things were at the worst, business was almost wholly arrested ; the courts were closed ; the hospitals overflowed with cases of heat-apoplexy from the shipping in the river ; people were afraid to take their horses out, and even the owners of the wretched traps, which represented cabs and were drawn by country-bred ponies ordinarily invulnerable to local climatic outrages, would not supply them except in the early morning or late evening. The sense of relief attending the onset of the first storm of the monsoon was an experience not likely to be forgotten, and I well remember entirely sympathising with the gate-keeper of the Zoological Garden, who, on being congratulated on the event, replied, " Sir, had that weather lasted much longer, we must all have died." Fortunately, even in the much-decried climate of Lower Bengal, heat of this kind is relatively rare, and indeed, during the whole time of my residence in Calcutta only one other instance of it occurred. This was in the year 1869, when a late and violent cyclone came off during the early part of June, damming the progress of the monsoon up the Bay of Bengal, and leaving behind it several days of stiflingly stagnant heat, during which the sun blazed fiercely down over land which had just been swamped by eleven inches of rain.

Even in quite normal seasons the heat at midday and in the early part of the afternoon is quite enough to give rise to very conspicuous effects. In the native parts of the town the streets are well-nigh empty; business is in abeyance; there are no eager customers about the open fronts of the shops, within which the dealers are either strewn about in heavy sleep or, at utmost, only awake enough to fan themselves with an air of torpid resignation. A strange hush prevails in all the gardens, which in the morning and evening are alive with the notes and movements of innumerable birds. Even the crows are for the time being subdued, and sit about in the shade, gasping with widely opened beaks, and either quite silent or at utmost whispering fitfully to one another; only occasionally is the whistling call of a kite to be heard; the babblers cannot wholly refrain from talking, but their conversation is sleepy and subdued; and the only birds who are seemingly entirely unaffected are the tailor-birds and honeysuckers, who continue to bustle about singing and shouting with unimpaired vigour.

Unless violent storms of rain set in early and take place frequently, the ground very soon becomes excessively hard and dry; great fissures form a network over it, even when the surface is clothed in grass; and, at the same time, many shrubs present a depressing show of wilting foliage every evening. Even in the absence of rain, however, the effects of continued heat in Lower Bengal are kept in check by the drenching dews which

every cloudless night add much moisture to the soil, and give leaves time to recover turgescence during the temporary arrest of evaporative loss of water. So long as the nights are clear and dewy, foliage, which at sundown appeared to be dying, is fully revived and loaded with sparkling drops of moisture on the following morning; and lawns, although more thinly clad and less vividly green than at other times of year, hardly ever become converted into mere wastes of baked earth, as they are wont to be during the hot weather in drier parts of India.

In order fully to appreciate the value of nocturnal atmospheric saturation and abundant dew, it is only necessary to visit a garden early in the morning after a cloudy night, for then all the foliage will be found just as it was on the previous evening, the leaves of many shrubs hanging down in limp dejection, and all the grass dingily dusty and squalid. The benefits accruing from free and rapid radiation may also readily be realised on a smaller scale by observing the conspicuous localised variations in temperature which arise in connection with the presence of trees with widely spreading branches. On the great grassy plain—the so-called “Maidan”—round the Fort in Calcutta, there are a certain number of old isolated fig-trees of various species, whose growth has been curiously modified owing to exposure to the attacks of the herds of cattle which habitually graze there. The animals are always eager to vary their diet of grass, and in the attempt to gratify their desires destroy every leafy branch or shoot within their reach, so that the



trees have become converted into huge umbrellas with thick central stems, from which horizontal boughs radiate in every direction bearing dense masses of foliage. On crossing the plain on any still, clear summer night shortly after sunset, it will be found that, whilst the air over the large open spaces has already become gratefully cool, that beneath the canopies of the trees still remains almost as hot and stifling as it was in the afternoon and as it continues to be for many hours in those streets in the town in which large masses of masonry are continuous or at utmost only separated by small interspaces. In the streets, however, the persistence of high temperature is not so much owing to any great obstruction to radiation as to the stores of heat laid up during the day, and which are not completely discharged from the bricks and mortar until early in the following morning. Any one who has ever spent a summer in Delhi must remember the sensation of stifling heat which is experienced on passing within the circuit of the city walls after an evening spent in the relative coolness of the Ridge or the gardens and open spaces lying beneath it.

During periods of protracted heat and drought much interest may be derived from the study of the effects which are produced on different kinds of leaves by exposure to midday sunshine. In most cases simple wilting occurs and the plants seem to be withering; but in the case of nyctitropic leaves—in leaves in which the various parts take different positions by day and night—wilting does not usually show itself, but there is an assumption of the



normal nocturnal position. Every other condition—warmth, stillness, and strong solar stimulation—may be present to favour the diurnal position, but in the absence of sufficient moisture they are powerless, and the various parts of the leaves are arranged as they normally are during the earlier hours of darkness. That it is the want of moisture which is the determinant factor of the abnormal position can be easily ascertained by means of very simple experiment. If two pot-specimens of any common nyctitropic plant be exposed side by side in still air to the full blaze of noontide sunshine until their leaves have fully gone to sleep, and one of them be then treated to a copious supply of water, it will be found that within a short time its foliage has regained the normal diurnal arrangement, whilst that of the unwatered plant remains as soundly asleep as before. The diurnal position of the various parts of nyctitropic leaves is the direct outcome of temporary augmentations in the strength of particular masses of tissue under the influence of solar stimulation. This occasions an increased manufacture of hygroscopic substances, and these in their turn give rise to increased turgescence and strength in the tissues in which they are present so long as a sufficient supply of water is at hand ; but no degree of solar stimulation can lead to turgescence in the absence of water ; on the contrary, it can only tend to occasion decreased turgescence leading first to the assumption of the nocturnal position, and ultimately to withering. In the case of most leaves a defective supply of water leads merely to diffused loss of turgescence

causing general wilting; in that of nyctitropic leaves it at first only occasions alterations in the relative strength of particular and opposing masses of tissue and therefore causes displacements of the parts of the leaves on which they act.

The great event of the hot weather is the occasional occurrence of violent storms of thunder, lightning, wind, and rain. When of a typical character such storms come on towards the evening of a day which has distinguished itself by still and oppressive heat, bad enough to begin with but becoming well-nigh intolerable during the course of the afternoon. Then, low down on the north-western horizon of the previously evenly hazy and ochreous sky, a dense bank of cloud begins slowly to grow upwards, of a bluish grey at first but quickly darkening as it rises and advances a convex edge, pointing towards the zenith and preceded by circling flocks of kites who go luxuriously sailing aloft into the cooler breezes which it hurries before it. The air beneath is either seemingly motionless or is only traversed by fitful currents breathing gently in a direction contrary to that of the impending tempest. The cloud rises steadily, and over its towering masses flashes of brilliant lightning begin to play; its march loses its original stately solemnity and is suddenly hurried; there is “a rush and a roll and a roaring”; blinding clouds of dust darken the air, and a furious and seemingly cold blast rushes forth, tossing and tormenting the foliage, tearing off branches, bending or overthrowing whole trees, making the palms wring their hands in agony as they bend over almost

level with the ground, and driving every bird and other animal before it in quest of shelter from its might. Then, a few minutes later, "the windows of heaven are opened"; long lines of water shoot down upon the dry and gaping earth; there is, as George Meredith aptly describes it, "a gobbling sound" of rushing rain; a grateful smell of damp soil fills the air; presently the sky in the quarter from which the storm came up begins to lighten; the gloom in which everything has been wrapped gradually diminishes; lakes and pools of clear blueness appear amid the grey confusion of clouds; and in many cases the sunshine is already pouring gaily in on one side while on the other the blast is still hurrying onwards in tumult and darkness. The rapidity and range of the fall in temperature attending the passage of such a tempest is often quite surprising, the thermometer frequently showing a descent of as much as 20° F. within the course of a quarter of an hour. The immediate impulse is to take advantage of the sudden coolness and escape from the oppressive heat which has been prevailing indoors by going out at once, not exactly into the open, for the fury of the wind and rain forbid that, but into the relative freedom of any sheltered verandah; and any return thence to the interior of the house rouses a lively sense of wonder that existence should have been possible under the conditions which continue to rule there until the violence of the storm is over and all the doors and windows have been widely opened.

The shows of cloud-effects attending these storms



are almost always impressive and often quite magnificent. There is something almost alarming in the sight of a solid bank of cloud rising over the horizon and slowly and steadily travelling upwards over a clear sky in a direction opposite to that of any movement of the air at the surface of the earth; but it is usually on occasions on which the storm is of somewhat abnormal character that the most wonderful displays occur, and I have never forgotten the impressions produced by one of them. The clouds came up at first in a great continuous curtain of dark grey, rolling folds, sweeping up from the north-western horizon and travelling onwards until, when they had already begun to descend towards the south, they suddenly broke up into towering heaps of varied shades of grey and umber separated by intervening rifts of light blue sky, whilst at the same time a diffused glare of pale saffron radiated out of the north to form a brilliant background for a procession of ragged, deep brown masses of vapour. The movements of the multiform clouds were superb, mountainous piles moving slowly along, often in opposite directions, and all fitfully blazing up under diffused flashes of lightning, whilst thunder rolled heavily around in muffled peals overhead.

During the earlier part of the hot weather the storms are sometimes accompanied by hail-showers of portentous vehemence. Very often for several successive years there will be little or no hail, and then a fall will take place of a quality well fit to restore the average. The last noteworthy hailstorm



which took place during my time in Calcutta came off on a Sunday afternoon towards the middle of March 1894. The early morning and forenoon had been in no way remarkable, but as the day grew on the air became very still and oppressively hot, and early in the afternoon a great black cloud rose up in the north, marched slowly upwards and ultimately broke in furious wind and deluges of great hailstones which played havoc among the newly opened leaves and covered the grass with a thick white layer of ice. Whilst the tempest was in full force it was impossible to leave the shelter of the verandah; but when it had in some degree abated I ventured out into the garden and secured one or two large hailstones, and one of them, when accurately measured by help of a pair of callipers, proved to be one inch and three-quarters in diameter and half an inch in thickness. It formed a disc with a spherical core of clear ice, surrounded by a series of alternately transparent and opaque bands arranged like the layers of an onyx. It is bad enough to be caught in the open by a storm of this kind whilst on foot, but it becomes really dangerous to be exposed to one whilst riding or driving; for horses are, not unnaturally, apt to be driven wild by pain and fright when suddenly bombarded by great missiles which are often beset with jagged, projecting spikes and tubercles.

Such are the main features of characteristic "nor'-westers," but storms sometimes come up in abortive fashion, and unaccompanied by rain. In these cases they give rise to comparatively little fall of temperature, and closely resemble the "dust-

storms " of Upper India. Sometimes, too, a bank of cloud will appear and rise to the zenith in quite normal fashion, but then, without the occurrence of any violent wind at ground-level, break up into rolling masses, which hurry onwards without yielding any rain, and either vanish in the south, or, after appearing to be about to do so, suddenly return on their course and discharge their contents of thunder, tempest, and deluge. It is only in the course of abnormal years of drought that true dust-storms—breathing blasts like those from a furnace, out of dense black clouds of dust—occur in Lower Bengal ; but now and then storms of otherwise normal characters will come up from unwonted directions. One of this kind took place in the summer of 1881, and, although very brief, gave rise to great havoc among trees, partly on account of its excessive violence, but to a great extent because, coming up as it did from the south-west, it took them just where they were not prepared to resist any special strain. It occurred in the late evening, and the effects of its fury were sadly conspicuous on the following morning ; for the surface of the maidan was thickly strewn with wreckage of smashed and uprooted trees, and here and there at the sides of the roads overturned and broken carriages marked the places where they had been overtaken by the full force of the blast. Some trees, like mahoganies, had been snapped cleanly across, and others, especially so-called "cork-trees," had been simply upset and lay, like trees out of a Noah's ark, lifting up great discs of roots and turf into the air. The tracks which had been

followed by individual blasts of exceptional intensity could often be clearly traced by the ruins along their courses, and it was curious to see how sharply defined the violent currents must often have been. In one part of the Botanic Garden a narrow lane had been cut out through the thickest part of a large grove, all the trees along its course having been either uprooted or broken to pieces, whilst those on either hand showed hardly any signs of injury or disturbance.

During the course of some seasons violent tempests are more or less completely replaced by thunderstorms like those of the rainy season, unattended by any furious wind, and yielding quiet, heavy showers. The show of lightning in such cases is often magnificent, great sheets of white, violet, steely-blue, or rose-colour, and wavering lines of intolerable splendour alternating with blinding cataracts of light, which seem to fall vertically upon the horizon. Whilst such storms are in progress, and even oftener under the stress of violent nor'-westers, strange visitors—great dragon-flies, bats, and birds of many different kinds—are often driven to take refuge in houses from the pitiless wind and rain.

In the driest and hottest weeks of almost any year, but especially in unwontedly arid seasons, curious miniature whirlwinds often make their appearance in addition to the larger disturbances which have just been described. They are neither so common nor so violent as those which are to be seen in many of the drier parts of Upper India, in which any open sandy plain is often tenanted by



groups of dust-columns travelling slowly about on devious tracks, and circling round one another as though engaged in some solemn ceremonial dance. Their stately progress through the surrounding still air and the evidences of their intrinsic furious energy afforded by the way in which they suck in any loose objects which lie in their tracks, are certainly very uncanny and quite enough to explain why they are frequently referred to in the *Arabian Nights* as manifestations of Jinn, and why the natives of India ordinarily call them Shaitān. Even in such a damp region as Lower Bengal a wide area covered by masses of masonry, like Calcutta, is often capable of providing local conditions favouring their development, and I have more than once had my progress along a street temporarily stopped because my coachman had drawn up in order to let a Shaitān, who was travelling along a track which crossed ours, sufficient time to go by. The most remarkable thing about these toy-cyclones is the extremely sharp definition of their outlines which allows them to build up towering columns of dense, circling dust, into which sticks, straws, and even much heavier objects are absorbed and whirled aloft, whilst all around the air remains breathlessly still.

When great storms bringing abundant rain take place late in the evening or during the course of the night, the succeeding mornings are usually quite delightful, but perhaps those after quiet thunderstorms are even more perfect than those following typical nor'-westers. The sky is often not quite clear, but has a grandly spacious aspect



and is clothed in heaps of deep blue, soft neutral and silvery white clouds among which drifts of rain fitfully appear. The grass is everywhere thickly strewn with fading leaves brought down by recent showers, and all the young foliage is clean washed and shining. Now and then stray gleams of yellow sunshine steal in, and, as they grow in strength, throw out all the tender green tints on the fig-trees and tufted masses of bambus in brilliant contrast to the deep neutral blue of the upper sky. Everything is very still and seems so pure and peaceful as to arouse a disposition to "walk softly," and absorb gentle influences at leisure. Birds are in great force and take full advantage of all the opportunities of shikar offered by the moist heaps of fallen leaves and the damp and softened earth. Crows hurry round, many of them laden with materials for the repair of nests damaged by the recent tempest; koils shriek with ear-splitting vehemence; kingfishers "cry to their fellows"; and geocichlas show their beautiful russet and slate-blue plumage as they tread about over the dead leaves and hammer noisily whilst breaking up the shells of snails lurking among them.

Many trees continue to make a wonderful show of colour for some time after the real hot weather has fairly set in. The siris-trees soon become clothed in radiant greenish-white blooms, which load the air at night with a heavy sweet odour like that of the chambeli-oil which the natives love to extract from the flowers of the mogra, *Jasminium Sambac*. Whenever the nights become steadily warm the trees of the kanak-champa,

*Pterospermum acerifolium*, begin to break out into young foliage and warm brown buds, which presently unfold in nightly crops of large leathery white corollas, falling in showers, each successive morning to be eagerly collected and used in the manufacture of a kind of sherbet. The smell of the flowers is purely and delightfully fragrant, and is so widely diffused by the air that it often serves to reveal the presence of the trees long before they are within sight. The leaves are singularly ornamental, and when mature are of considerable size, dull green above and seemingly thickly washed with oxidised silver beneath, so that, when stirred by a light breeze, they make a lovely show. Like those of other kinds of *Pterospermum*, they cannot be said to unfold, for they are gradually developed by simple processes of marginal growth. The great groups of bambus are specially attractive, with all their lower branches veiled in mists of tender green leaflets and the upper ones still shooting aloft in the grey and gold of fading foliage and scattering showers of falling blades; the devdars, *Polyalthia longifolia*, are for the time being glorified into spires of brilliant golden green by budding leaves and crowded inflorescence; *Erythrinas* flaunt it in spikes of scarlet and crimson, which shine like jewels in the sunlight and are constantly haunted by waving clouds of butterflies; and the gābs, *Diospyros Embryopteris*, become quite as softly beautiful in tufts of pale rose-madder shoots as they would be were they clothed in masses of bloom. The flaming orange and scarlet flowers

of the so-called "gold muhar-trees" soon begin to show and presently unfold in such profusion as almost entirely to hide the foliage and form masses of saturated colour, which are certainly very striking but may readily become offensive in their glaring intensity. When planted among other trees they are wonderfully effective, but when set in lines along the sides of roads so as to form continuous avenues they become pure outrages. One street in which I lived in Calcutta had been planted throughout its whole course with them, and the sensations attending entrance into it during the course of a blazing day in May were certainly not those of gratitude for the provision of such a glaring environment. It is at this time of year, too, that the various species of *Lagerstroemia* come into fullest flower and are covered by splendid plumes of delicately fringed corollas; the small shrubs commonly cultivated in gardens lovely in white, lavender, and rose, and the larger roadside trees glorious in heavy masses of foliage and mauve golden-hearted blooms. One of the most remarkable displays of inflorescence during the hot weather is that which is furnished by various species of Cycads (Plate XIII.). The great yellow cones of male flowers are quite superbly decorative, but it is impossible to use them as ornaments in a house owing to the odour of their pollen, which not only is highly offensive but also causes violent sneezing. I once carried a cone from the Botanic Garden to my laboratory in Calcutta, and during the whole of the three miles' drive suffered from a severe fit of hay fever.





PLATE XIII.—MALE CONES OF A CYCAS.





For some weeks after the dry heat of noon has become overpoweringly strong the early mornings remain quite cool and fresh, and birds of all kinds revel in their enlivening influences. Cuckoo-shrikes pry curiously among the foliage of the higher trees ; ioras hop about uttering prolonged whistling cries, and every now and then flying aloft and dropping straight downwards to the accompaniment of a series of strange loud notes ; orioles flute to one another "in full-throated ease" as they leap from tree to tree, waving streaks of shining gold ; parties of common mynas go hurrying out on their daily rounds, and a few grey-headed ones persist in futile examination of the silk-cotton trees in the vain hope of finding lingering blooms among the crowded masses of capsules which are already beginning to gape and discharge their downy white loads. Numbers of young crows are already hatched, and their callow notes mingle with the raucous ones of their parents who are now highly irascible and ever ready to rush out in assaults on passing kites or lurking koils ; small flocks of river-terns occasionally pass overheard *en route* from the Hugli to the great eastern swamps ; and now and then troops of migrants sweep across the upper sky steering steadily northwards. The common white-breasted kingfishers are busily courting, and rival males are everywhere showing off their vivid plumage before seemingly indifferent and uninterested females ; a shikra-hawk sometimes comes drifting in to be immediately set upon by mobs of indignant king-crows and other nesting birds ; babblers are already beginning to stack heaps of

rubbish among the boughs in the fond idea that they are building; and all around palm-swifts go drifting about in clouds, uttering little shrill cries somewhat like those of common bee-eaters. Everywhere, too, insects of many different kinds abound; splendid butterflies flaunt and float over the flowering shrubs; and strangely localised clouds of dragonflies hang in feebly flapping flight over the margins of all the open spaces.

As the day wears on, however, the morning breezes die off and all through the succeeding hours the heat is relentlessly piled up by the continued blaze of sunshine. A great and heavy stillness settles down about noon; the earth bakes and cracks; the heat on exposed masses of masonry becomes intolerable; a deep hush falls on almost all birds; the leaves of many trees and shrubs begin to droop or go to sleep, and everything seems to gasp for sunset and the arrival of "the long breeze" to bring its burden of coolness and moisture from the sea. When it does come up, the voices of birds begin once more to sound out and go on steadily multiplying their "sweet jargoning" until the dusk is already well advanced. Then, as the general concert gradually dies down, the shrill little notes of drifting flocks of swifts once more become distinctly audible; small bats begin to flicker out of their lairs, their feebly wavering flight contrasting strangely with that of the swooping birds; until it is almost dark, a few belated king-crows go on hawking from the topmost boughs overhanging open spaces of grass, leaping upwards into the air to wheel suddenly

over and sweep back to their perches on widely extended wings; blue-throated barbets and koïls call fitfully for a time, and then gradually fall silent just when the noisily chattering choruses of the little spotted owlets begin to break out in full force.

Then when night has fairly set in, the moon and stars blaze out in an intensity unknown in temperate regions. Even the very brightest moonlight in the British Islands produces little more than mere photographic effects of light and shade, but, under a tropical moon, the night "is but the daylight sick" and the chiaroscuro is softened and veiled by subdued tints of tender colouring. All the roads gravelled with pounded bricks glimmer in delicate pink; scarlet uniforms retain a strong red hue; the grass, in place of looking grey, is of a subdued green which strengthens in the heavy masses of foliage on the trees where innumerable little lambent flames twinkle as the rays are reflected from the polished surfaces of individual leaves. The air is not clear enough to let the stars produce quite the same effects as they do in desert regions, such as Upper Egypt and Nubia, where the Nile is nightly covered by countless trembling lines of light, and where each individual star remains clearly defined until it suddenly dips beneath the horizon; but their brilliant and multitudinous show is overpoweringly magnificent and well fitted to make any one feel with Pascal that "*le silence éternel de ces espaces infinis m'effraie.*" There can surely be few more awful experiences than that of spending a solitary midnight hour on a terraced



roof in looking out into the jewelled expanse of a tropical starlit sky !

As the season advances the air no longer has the stimulant dryness which it had when the heat first set in ; the nightly breezes become weaker and less constant ; the sky by day loses more and more of its divinely clear blue as ochreous fringes of haze steadily climb up from the horizon and ultimately converge to form a uniform yellowish curtain through which a cruelly powerful sun beats down ; even in the morning and evening there is hardly any sensible freshness about the air, and there are no longer any recurrent storms to clear and cool it ; a great longing for the advent of the monsoon falls on every one ; and days spent in closed and carefully darkened rooms, in which the air is stagnant unless within reach of the pankhas, and silent save for the vicious hot hum of mosquitoes, the shriller notes of solitary wasps busy in building or stocking their nests, or the “cric-cric” of hornets gnawing at the beams overhead, become more and more oppressively tedious.

## CHAPTER XIII

### “ THE RAINS ”

How beautiful is the rain  
After the dust and heat.

LONGFELLOW.

Fills the shadows and windy places  
With lisp of leaves and ripple of rain.

SWINBURNE.

He bringeth forth the clouds from the ends of the world ; and sendeth forth lightnings with the rain, bringing the winds out of his treasures.—Ps. cxxxv. 7.

IN Lower Bengal the rainy season very seldom sets in at all theatrically—as a rule, there is nothing which can be fairly described as a “burst of the monsoon.” This may doubtless be in part accounted for as the result of the fact that in that part of the Gangetic area there is no such antecedent period of heat and drought as that which occurs in many other parts of the Peninsula ; but, at the same time, the knowledge that almost every year several distinct “bursts” are recorded as having taken place in Bombay and Colombo, has a tendency to provoke a certain amount of scepticism in regard to the normal occurrence of the event in any part of India. In so far as Lower Bengal is concerned, there can be no question that there are years in which the advent of the monsoon is announced by violent storms in which “the clouds

pour out water, the air thunders, and arrows go abroad"; but much oftener it comes in quite quietly with a gradual increase in atmospheric humidity and a steady piling up of masses of clouds until their burdens become too heavy to be borne and are discharged in streaming rain which comes down as suddenly and violently as though some one had pulled the cord of a celestial shower-bath.

In whatever fashion the rains may begin, the period immediately before their onset is almost always one of weary longing and anxious outlook for the appearance of the first harbingers of a change of weather. The latter part of the season of dry heat is usually felt to be much more trying than the beginning, partly because continuous exposure to high temperature has served to wear down the store of vigour which may have been laid up during the previous winter, but also on account of the growing moisture of the air, the absence of refreshing storms, and the feebleness and fitful character of the nocturnal breezes. As day follows day in tedious and augmenting oppression, the south-eastern horizon is more and more anxiously scanned for any signs of defined clouds to variegate its fringe of yellow haze; and any significant peculiarities in the ongoings of birds or insects are eagerly watched for and gladly hailed when they appear. It is always a good omen when the brain-fever-cuckoos begin to replace tedious repetitions of their name-calls by series of notes in a descending scale; it is cheering, too, to see adjutants beginning to float high overhead like dragons in the upper sky, or descending to stalk about in dignified companies

over open spaces of grass ; but by far the most trustworthy index is afforded by the behaviour of one of the commonest kinds of dragon-flies. All through the course of the hot weather hordes of feebly flying creatures with spotted wings waver vaguely about every morning and evening above the lawns, while in the weedy fringes of ponds numberless slender beings are perpetually gliding to and fro or resting on the yellowing leaves ; but it is only on the approach of the monsoon that the great dingy brown insects, who abound during the rainy months and the earlier part of winter, begin to come out in force. Clouds may gather again and again on the horizon only to melt away during the heat of the day ; the brain-fever-birds may be deluded by the dampness of the air preceding mere casual storms ; the arrival of the adjutants may have been determined by conditions prevailing in their far-off breeding-haunts ; but the brown dragon-flies have a finer sense and hardly ever make a mistake, so that once they have begun to appear in large numbers it may confidently be expected that the monsoon is about to arrive. Shortly after the first flooding downpours of rain have taken place another sign of the change of season is afforded by the behaviour of the common kites, who for a time desert their wonted urban haunts and betake themselves to the surrounding country in order to feast upon the numbers of large insects and small mammals who have been drowned by the sudden deluge ; but in this case we are dealing with a mere advertisement of a foregone event, and one, too, which may be issued



at any time of year after violent rainfall, whereas the dragon-flies play the part of harbingers, and only do so in respect to the monsoon.

How often, after a stray and passing shower, has any sign of their presence been eagerly looked for; and, even before there was anything else to foretell the approach of the monsoon, what a joy it has been to see swarms of them beginning to dart and wheel about over the baking streets and pitch down in headlong fashion to settle in long files along the telegraph wires at the sides of the roads! After they have once decided to come out they continue to be very abundant all through the course of the rainy season and autumn, and it is not until well on in the succeeding winter that they gradually disappear and are replaced by their relatives with spotted wings, who predominate in summer. Even during the monsoon, however, their numbers vary greatly from time to time; they may be relatively inconspicuous for a while, and then a day will come when all the air is again full of sweeping and circling swarms crossing and recrossing one another in mazes of airy dances. Whilst on the wing they sometimes float and drift lazily about, and then the presence of some alluring prey will suddenly stir them up to swoop and dart about in furious energy, scooping up victims as they go.

Perhaps the best way of giving some idea of the experiences and conditions of the period immediately preceding and actually attending the onset of the monsoon may be simply to transcribe a set of notes which was taken down during one season

in which the advent of rain was considerably delayed and the antecedent period of oppressive heat correspondingly prolonged. The record opens in a hopeful tone on June 15th, the statutory day for the arrival of the monsoon, with the statement that "after eight or ten days of pitiless heat there are at last some signs of the approach of the rains. After a night of still, stifling heat the morning sky was, as it always has been of late, covered by a uniform yellowish haze, through which a belated sun struggled out to diffuse a sickly glare all through the earlier part of the day. But, as the afternoon wore on, the colour of the veil gradually changed from ochre to grey, and at the same time faint wisps and streaks of cloud grew out of it and a light breeze began to stir fitfully, coming up in little wafts from the south-east and gently heaving the heavy plumes of the bambus, the crowns of the palms, and the topmost boughs of other isolated trees. The crows, who had been as nearly dumb as they can be during the breathless heat, began to talk aloud; subdued notes of small birds were audible; swifts came out and began to drift round in low-flying troops; there was a delightful sense of freer breathing; in the far distance faint and muffled sounds of thunder began to roll round the horizon; the sunshine brightened, and a great brassy glare lighted up in the west and cast splendours over all the heavy masses of foliage, making them stand out in vivid golden green with patches of brilliant scarlet, where stray heads of bloom yet lingered on the Poincianas." These appearances were, however, deceptive;

for three days later it is noted that "no rain has yet fallen, and deadly heat continues. At noon the sky was of an even greyish yellow, with a pallid, sharply defined sun blazing down on trees whose wilting foliage threw black shadows on the dusty roads and parched remnants of turf. Human beings were either sleeping heavily or seemed to be half stupefied, and the cattle and other animals strewed about in the shade had a pitiful air of dull endurance. Crows sat about among the branches with gaping beaks, and only a few bold kites braved it out and continued to circle slowly about low down on the eastern horizon, where one or two patches of cloud remained unconsumed by the heat. Almost the only birds who seemed to be up to saying anything were the blue-throated barbets, and even they only indulged in fitful and much subdued spasms of calling."

Three days more passed without any rain; but the brown dragon-flies had begun to come out in force and show off their bold, vigorous flight in contrast to the feeble and wavering efforts of their hot-weather relatives. A strong southerly breeze had also set in—at first breathing fitfully out of a cloudless sky, but a little later becoming continuous and hurrying up large, loose, ragged masses of cloud, which gradually accumulated over the whole sky. Notwithstanding these encouraging signs, there was not any actual fall of rain during the whole of the next week, and the outlook would have seemed very black but for the fact that the dragon-flies, in place of showing any symptoms of repentance, continued to appear in steadily growing

numbers. It was not until the evening of June 29th that it was safe to affirm that the monsoon had fairly arrived. Then, however, the sky overhead and to the east was covered by delicate swathes of vapour of all shades of lavender. At a lower level defined greyish clouds moved slowly upwards in shifting processions; whilst at the level of the ground not a breath was stirring, and the cries of the roosting crows filled the air with ceaseless din. But even after this no steady rain fell for some time, and it was not until July 5th that continuous wet weather set in. Then the humidity of the air underwent a great increase; frequent deluging showers occurred in rapid succession; many trees began to throw off their summer foliage; the dried grass shot up into masses of rank and dripping verdure; and all the swampy hollows were full of bellowing bull-frogs. In this particular season the period between the end of the typical hot weather and the beginning of the rainy season was unusually prolonged; but the conditions which prevailed in it may be taken as fairly representative of those which ordinarily characterise the "burst of the monsoon" in Lower Bengal.

Very soon after the air becomes continuously damp a great flush of fresh foliage breaks out. In the case of some trees this new growth is not attended by any considerable fall of old leaves, but in that of others, such as country almonds (*Terminalia Catappa*), siris (*Albizia Lebbek*), and rain-trees (*Pithecolobium Saman*), the fall is almost as complete as that which takes place in the end



of winter. Many of the country almonds are once more splendid in the varied tints of the fading leaves which they shower down to carpet the ground below, and at the same time begin to show vivid green shoots and budding spikes of flowers. The mangos, on the other hand, hardly throw off any leaves at this season, but merely cover the dark masses of their old foliage with bronzy tufts of young growths.

Owing to the conditions to which the abounding young foliage of the earlier part of the rainy season is exposed, many striking examples of rapid foliar movements may at this time be easily observed. Many different kinds of leaves, which when mature only show slow and limited movements, are now in a state in which they are able to execute rapid and extensive ones, and the frequent recurrence of violent downpours of rain provides mechanical stimuli to call their powers into play; capacities for foliar movements are at a maximum, and the meteorological conditions of the environment are such as to favour their exercise. It has been pointed out already that excessive drought is enough to lead nyctitropic leaves to take up their normally nocturnal positions during full exposure to sunlight, and in the present case mechanical agitation serves to produce a like result in spite of the presence of excessive moisture. It is very impressive to watch the behaviour of a great rain-tree in full fresh foliage under the influence of a sudden and violent fall of rain, and to see how rapidly the leaves pass from a state of fullest expansion into the condition usually associated

with the absence of solar stimulation. In the case of drought the nocturnal position is caused by the want of a proper supply of water to meet the demands of certain masses of tissue which are specially active in manufacturing hygroscopic compounds under the influence of sunlight and consequently acquire adventitious strength by absorption; in the case of exposure to violent impulses from rain the strain and pressure to which they are subject causes them to lose turgidity; and at night a like loss is occasioned by diminished manufacture of absorbent materials. In all cases the masses of tissue which make for the diurnal position are structurally weaker than those which oppose them, so that, whenever solar stimulation or a proper supply of water is absent, or any abnormal strain and pressure present, the various parts of the leaves at once tend to assume their normally nocturnal positions. In all cases alike the assumption of the normally nocturnal position is the result of losses in turgidity in certain masses of tissue which are physiologically stronger but structurally weaker than those which oppose them; but such losses may be occasioned by several distinct causes—they may be owing to decrease in supply of absorbent materials, to defective supply of water to be absorbed, or to the presence of mechanical conditions interfering with its retention when absorbed.

There is not quite so great a show of flowering trees at this time as in spring, but some species which bloomed then do so again in less degree, and others are now covered with flowers for the

first time. Among these there are very few more striking than the Kadams (*Anthocephalus Cadamba*), which are so familiar to all readers of the *Prem Sagar*. For the time being they become trees of the Hesperides, covered with spheres which are at first green, then creamy white and radiant with projecting corollas and stamens, and finally bright golden yellow. In all its later stages the inflorescence is marvellously decorative in its contrasting tints of white and gold upon a background of large and deeply veined leaves. The country almonds very soon show their second crops of blooms, and the maple-leaved *Pterospermums* again fill the air with far-reaching fragrance. All the roadside banks and ditches become the sites of luxuriant vegetation; various kinds of aroids send up groves of delicately shaded leaves and white or wine-coloured spathes which too often have a vile odour; ferns quickly shoot up crosiers and young fronds in every direction; and all the shrubs and hedges are invaded by strangling masses of gourds and passion-flowers. At the same time fungi of many different kinds assert themselves; pale yellow mushrooms break out amid the damp heaps of fallen leaves; crowds of little, shell-like growths burst forth on the surface of dead branches; decaying canes of bambus are clothed in furs of bright yellow or purple, formed by innumerable little pin-like objects; the strange and multiform fruits of *Mycetozoa* abound on rotting wood; and all the lawns are thickly starred over every morning by the fugacious, radiant heads of minute *Copрини*, which melt and vanish away when the sunshine strikes upon them.



Unless when it is attended by continuous, drenching rain, lasting for several successive days, the onset of the monsoon is always accompanied by abundant evidences of renewed activity in animal life. Hosts of monstrous bull-frogs suddenly come out to bellow in all the patches of slushy grass ; parties of young birds, accompanied by their anxious parents, wander eagerly about over the moist lawns whose surfaces are everywhere thickly strewn with fresh worm-castings ; scops-owls begin to cry softly all through the course of the nights ; enormous dragon-flies with banded bodies and stiff, rustling wings dart to and fro on marauding excursions ; and all the jungles of long grasses around the ponds are alive with smaller and gentler species. Great, shining, blue bees, whose wings are brave in reflected gold and bronze, sit sunning themselves on bare twigs or hurry through the air with deep, resounding hum ; and everywhere all the open spaces are full of splendid butterflies. Great black and scarlet swallow-tails hover over the glowing masses of bloom on the *Ixoras* ; large white creatures with loosely flapping wings waver madly about and pursue one another in intricately tangled dances ; smaller blue and yellow ones are constantly travelling through the groves of long grass, and everywhere there is a bewildering show of moving patches of vivid colour.

The early morning hours are often quite enchanting under such conditions. It is a perfect revelation to go out into a garden at sunrise and find that, although there are a few low-lying banks of cloud, and perhaps, far down in the south-east,



some curdled masses beginning to pile up for the day's work, only two or three delicate swathes and flocks of vapour break the pale blue expanse of the upper sky. All the grassy levels are still in deep shade, and any trees to the eastwards stand up in cool, deep green against the growing radiance, while level beams of sunshine stream in over them to gild the tops of those to the west. The surfaces of the ponds lie like mirrors, motionless in the shade and sheltered by the abrupt slopes of their banks from the fitful and gentle breezes which come whispering in from the south; a few blooms of *Nymphæas* shine out, stars of white or crimson, among surrounding rafts of deep green leaves; and, all around the margins of the water, the polished fringes of *Limnanthemum* are dotted over with shining white flowers. Scarlet masses of bloom mark the places where *Ixoras* stand amid the thick green of the shrubberies, and feathery plumes of *Lagerstroëmias*, white, rose-coloured, or lilac, here and there catch the slanting sunshine. All the foliage has been washed by recent rain, and the leaves of pipals and *Ficus nitida* glint with blinding tongues of radiance; yellow spires of bloom rise against the blue from the tops of all the trees of *Cassia siamea*; and, down below, thickets of *Cannas* hold up their wine-coloured fronds and heads of dull red flowers in the surrounding gloom. The rank grass in the shrubberies and unmown lawns hangs down heavily burthened by adherent drops of water, and among it and the wet foliage around butterflies begin to awake, dry their drenched wings and flutter lazily about. *Otocompsas* and

brown bulbuls cry cheerily from the topmost boughs ; now and then an oriole flutes aloud as he leaps through the air from one tree to another ; spotted doves converse in subdued tones and occasionally tower aloft on clapping wings to sail downwards with widely spread quills ; at intervals the loudly cackling cry of a gold-backed woodpecker strikes harshly in ; and all around, kingfishers call and show off their splendid plumage. Parties of mynas and sturnopastors are already racing and pacing over the damp turf ; all the bushes of *Hamelia patens* are alive with the sweet little notes and twinkling wings of honeysuckers ; tailor-birds shout in the coverts ; the koïls have got through their morning fits of screaming and are so busy over their breakfasts as to be temporarily dumb ; blue-throated barbets occasionally set the air vibrating with their thrilling notes ; the deep hooting of crow-pheasants sounds out from tangled thickets ; and all the air is full of the shrill whistling of kites and a noisy torrent of vulgar talk from the crows.

Experiences of this kind provide stores of memories of unmingled pleasure ; but it must not be supposed that the rainy season is necessarily a period of continuous enjoyment. On the contrary, it is only too often characterised by spells of weather in which the rainfall is either so fitful and scanty as to give rise to the development of oppressive heat, or so excessive and continuous as to occasion conditions of general saturation which, along with the gloom of persistently clouded skies, serve to render life a burden both within doors

and in the open air. It would be hard to say which of these alternatives occasions the greater degree of discomfort. A regular "break in the rains" is certainly very trying, for, although the thermometer goes on obstinately affirming that the heat is by no means excessive, and that the temperature of the air is many degrees lower than it was during the earlier part of the summer, the sensation of heat is much more oppressive than it was then, because the dampness of the atmosphere is unfavourable to rapid evaporation from the skin, and also because the nights are no longer blessed by the presence of regular sea-breezes, but have become stagnantly breathless. The sensation of great heat when associated with darkness is always peculiarly irritating because it seems to be so irrational—that it should prevail under the influence of blazing sunshine is naturally accepted as being within the rules of the game, but to have periods of gloom and darkness yielding no appreciable relief can hardly fail to appear unfair. The evils attending excessive rainfall take somewhat longer to reveal themselves; but, when once established, they too are very hard to bear. When a long succession of persistently clouded days and incessant deluges has rendered everything so damp that even the bedding is clammy and musty; when the matting on the floors is every night beset by thin webs of mould in which each passing footstep leaves a visible print; when on each successive morning boots and shoes are found covered by fleecy growths of mycelium; when troops of fugacious yellow mushrooms spring up in the corners of rooms; when writing-paper



becomes so sodden that ink runs and spreads over it ; when it is perilous to walk along garden paths because they are coated by brown gelatinous algæ ; and when it has become apparently impossible ever to feel clean or dry,—it is not unnatural that the conditions which prevail during the hot weather, or even even those of a prolonged break in the rains, should come to be temporarily regarded with envious regret.

In most years, however, there is little to complain of during the whole course of the monsoon, and, even in those in which breaks or periods of excessive damp prevail, these are usually of such relatively brief duration that the prevailing memories of the season are pleasant ones ; as is usually and happily the case, reminiscences of times of discomfort rapidly fade, whilst those of hours of the fullest joy in sights and sounds peculiar to the time of year stand out persistently and clearly defined. Even breaks in the rains have certain good points. They may often be painfully oppressive, but under no other conditions are more glorious skies to be seen. There is now no sickly glare like that which prevails during the hot weather, and the monotonous clearness of winter skies is happily replaced by an expanse of the purest blue against which magnificent and multi-form masses of variously tinted clouds are heaped up. The wealth of fresh foliage, too, is quite superb under the clear sunshine, although its picturesque value may be marred by the uniformity and almost fierce greenness which prevail in it.

It is only when the rainfall becomes unusually



continuous that any disposition to grumble at it arises, and the first few steadily wet days of the season are almost always keenly enjoyable. Heavy, drenching showers—showers which, in streaming intensity, exceed the most violent of those attending thunderstorms in temperate regions—follow one another in quick succession, coming down like curtains out of a low and lowering sky, which, toward the horizon, is of a deep neutral blue fading off above into an even canopy of dirty grey. Now and then, in the intervals between violent down-pours, the veil overhead melts and lightens to reveal faint visions of delicate blueness, but very soon it thickens again as fresh troops of clouds come hurrying up from the south, and presently a new rush of rain is audible, marching steadily across the thickly wooded country in the neighbourhood until the trees close at hand are forced to join in the concert. Swifts sweep round among the heavily laden branches, shrieking as they go ; during the dryer intervals a few adventurous crows come down to settle on the plashy grass, their plumage drenched and showing whitish lines where the matted feathers leave chinks through which the pale down shines out, but they are very soon driven off by renewed deluges, and flap disconsolately and laboriously away to the shelter of the nearest heavily leafed tree or the cornices beneath the broad eaves of neighbouring houses. Now and then an exceptionally brave myna tries to break into a cheery song, or a koil may attempt to call, but, as a rule, the birds—even the tailor-birds—are almost quite silent. There is a seeming

savageness about the intense greenness of the soaked grass and heavy masses of foliage, and it is quite a relief to see the scattered notes of warm colour which are furnished by brick walls and paths, tiled roofs, and the brilliant heads of bloom on *Ixoras* and *Lagerstroemias*. A silly white butterfly sometimes straggles out into the open, flying even more drunkenly than usual under the battering shafts of rain; the bulbuls, after vain attempts to maintain their wonted jaunty demeanour, throw up the sponge and retire to sit, very much puffed out and humped up and every now and then shaking little showers of water out of their wings, in the most sheltered spots they can find. Only the honeysuckers are irrepressible, and throng about the flowers on the shrubs of *Hamelia* and *Duranta* as busily and cheerfully as though it were the finest weather. The rain continues to come down in shower-baths with dropping intervals, during which new troops of clouds travel up; and in the longer periods of respite great bull-frogs come out from the cover of the shrubs, to sit bellowing on the squelching grass.

After a night of continued rushing rain, there is at first a strange silence in the early morning. Almost the only birds who dare to call are the mynas, and they only do so in subdued and half-hearted fashion. Presently blue-throated barbets will begin to thrill in a doubtful way, and parties of moist and puffy babblers try to converse in low tones as they flounce and splash about over the soaked turf. During any periods of lighter rain the deep grunting of bull-frogs begins to fill the

air; doves coo gently, and an undertone of the notes of toads and crickets fills up all the pauses; while, whenever the fall really ceases for a time, the loud hooting of crow-pheasants resounds from all the thickets. When rain continues to come down steadily after dawn an even greater hush prevails. Even after daylight, such as it is under the prevailing gloom of the sky, has fairly set in, the swifts; the indomitable honeysuckers; and pairs of mynas, urged on by the incessant demands of ravenous chicks, are often the only birds to be seen or heard for some time. The air may be quite still down below, but up aloft a steady breeze drives ragged messengers of drifting vapour across a uniformly grey background. Most of the trees stand motionless, but now and then one of the fronds in the crown of a palm will begin to vibrate in an uncanny way as though stirred by voluntary impulse, or masses of soaking foliage will suddenly heave and scatter showers of great drops on the ground below. There is a diffused sound of rushing rain falling on the trees and grass, mingled with deeper notes caused by the streams which fall from the broad cornices of the roof on to the projecting wooden sunshades over windows. The grey levels of water in the ponds are dimpled over by the splashing impact of the deluge, save where muddy torrents rush down the banks and are continued in devious and discoloured streaks, spreading out in their course through jungles of half-drowned grasses to lose themselves in the general agitation of the open beyond. The quietness is so great that the feebly chirping cries of

the young mynas in nests over the beams and cornices of the verandahs become distinctly audible whenever they are eagerly uplifted on the arrival of the devoted and damp parent-birds bearing new stores of food. Suddenly a tailor-bird will shout once or twice ; a troop of bedraggled babblers occasionally races along one of the wet paths, or a spotted dove calls and dashes through the rain in noisy flight. There is an unwonted absence of the voices of frogs or insects ; for any steady, heavy fall of rain is just as repressive of them as it is of those of birds, and it is only during the intervals between showers that their concerts break out. This repressive effect of heavy rain is even more remarkable when it comes into play after dark, and so at a time in which the whole air ordinarily thrills with the cries of toads, frogs, cicadas, and crickets.

After prolonged experience of the uniform, pale glare of the sky during the hot weather, the cloud-effects of the rainy season are a ceaseless source of pleasure. It is only rarely that the whole sky is shrouded in an even mantle of grey vapour so as to look like the inside of a faded cotton-umbrella ; for, even when there are no “ windows in heaven ” opening out upon the blue, there are almost always local variations in the thickness of the curtain or distinctly overlapping masses of vapour, and very often the whole great vault is brave in a bewildering and shifting show of multiform clouds projected against a clear and radiant background. It would be hard to imagine anything more grandly spacious than some of the shows of cloud-perspective during



the intervals between successive showers on an intermittently rainy day in the endless levels of open rice-land which form such a characteristic feature of Lower Bengal. The fields sweep away to the horizon, clothed in all the varied shades of green presented by the young rice, ranging from the palled yellowish tints of seedlings which have just been set out, through the vivid emerald of older plants to the strong full hue of fully established ones, and form a sea of softly bright verdure only broken by darker lines of bambus or the shining blue levels of permanent ponds and flooded but as yet unplanted spaces; and all this brightly coloured plain is spread out under a grandly vaulted sky across which tiers above tiers of painted clouds pass in slow procession, lighted up by a wealth of gold which streams in wherever the rays of the sun can find a path through the interspaces,—it is indeed a case of "the spacious firmament on high."

The skies at sunset are often surprisingly splendid, and afterglows, which vanish in the evenly heated and hazy atmosphere of the hot weather, begin to reappear and assert themselves more and more strongly as the season wears on. Now and then, too, an exceptionally impressive evening arrives when the sun goes down among clouds luminous in strangely pearly iridescence, or on which great radiating bands of light and shade shoot upwards over a belt of vapour on the western horizon, and spread fan-like across the clear blue of the upper sky. It is towards the end of the monsoon that the forms of clouds attain their greatest variety and splendour, piled up in curdled masses of billowy

white, lavender, and deep indigo, or towering aloft into ominous columns, dominating the horizon and crossed by far-reaching streaks and bands of delicately tinted vapour. Even on the stillest and most oppressive autumnal evenings the glories of the sky at sunset are enough to induce temporary oblivion of the general sense of weariness and discomfort which is apt to prevail. All across the greater part of the sky there may be heavy masses of dun and neutral rain-clouds rising continuously from the eastern horizon, but at some point low down in the west these are abruptly replaced by light veils of rosy vapour and pools of the purest blue, while, still lower, columns of sharply defined and lavender-tinted clouds stand out against bands of the brightest carmine and gold.

Thunderstorms with grand displays of lightning take place frequently all throughout the course of the rainy months, but different years show great differences in respect to their numbers and intensity. Some seasons go by without any of a remarkable character, whilst, in others, magnificent storms follow one another in quick succession. The splendours of lightning are often quite indescribable, whether they take the form of cataracts of ascending and descending discharges, or clothe the whole sky in a maze of zigzag lines of insufferable splendour, or, towards the end of a storm, assume the character of diffused sheets of white, blue, or rose-colour. They are so seldom attended by the occurrence of any serious accidents that, unless by people of very susceptible nerves, they very soon come to be regarded with indifference or

admiration, save when they occur during the night with sufficient intensity to render continuous sleep impossible.

The latter part of the rainy season is usually distinguished by the occurrence of sudden torrents of brief duration, and often so sharply localised that in going along a road a point may be seen at which the track is crossed by a line, looking as though it had been artificially laid down, on one side of which the ground is dry and dusty, whilst on the other it is saturated with water. Showers of this kind are often astonishingly violent, coming down in streaming lines, which fill the air so thickly as to form a dense curtain behind which all objects even a few yards distant vanish; converting lawns into temporary lakes; scouring surfaces of recently upturned earth so violently as to leave them sprinkled over by crops of miniature mud-pillars capped by fragments of stone or brick, which have provided localised shelters from the vehemence of the deluge; dissolving and spreading out all the recent worm-castings; and washing down the mounds and plugging the openings of the caverns of the great autumnal crickets.

Even very short exposure to such furious rainfall is attended by very conspicuous results; low-lying areas are converted into ponds; streets are replaced by canals, and any slight differences in the level of the ground are quickly revealed; but, in order to realise fully what tropical rainfall can do, it is necessary to experience the results of a deluge which is not discharged by an isolated cloud but pours down continuously for many hours upon an

already saturated tract of country. Such an event occurred in Calcutta in the autumn of 1890, when during the course of one night eight inches of rain came down. The fall was not attended by either thunder or wind, and the night was so still that, although I spent it in a verandah, it was not until the following morning that I became aware that anything unusual had taken place. The outlook then was certainly remarkable; for, stretching away from the south side of the house, covering the whole of my garden and a large public one immediately adjoining, was a great sheet of water, only interrupted by half-submerged trees and shrubs and the lines of the upper parts of walls and railings, and in the distance rippling against the huts of a native village. The rain had ceased and the sun was already beginning to shine out through rifts in the clouds, so that, after waiting for several hours to allow the flood to diminish, I set out on my day's work, driving along a series of canals representing the streets leading to my laboratory. My old horse behaved, on the whole, with admirable composure, and took to wading as though he were quite used to it, unless at points where the confluence of roads at somewhat different levels led to the formation of violent and eddying currents. On reaching the maidan, which usually is a wide grassy plain traversed by rows of trees and shallow drainage-channels, a great lake was spread out before us, stretching away in continuous shining levels to the horizon, except where the surface of the water was broken by the walls of buildings, trees standing up to their knees in the flood, and



here and there slender horizontal lines corresponding to the highest parts of submerged roads. When I returned homewards in the course of the afternoon the inundation had in great measure subsided ; but even then, in the street lying to the west of my house, people were still busily occupied in catching great fish who had seized the opportunity of migrating from a neighbouring pond, and were now imprisoned in a pool contained in a local depression of the roadway.

On days during which sudden, violent downpours of rain take place the atmosphere is usually very still, hot, and oppressive, with scattered gleams of sunshine breaking through the interspaces of heavy masses of cloud until these have gathered enough to cause a temporary gloom. Then a loudly rushing sound, much like that issuing from thick foliage when suddenly stirred by a blast of wind, is heard, and at the same time one edge of the curtain of cloud melts off into a veil of blinding rain, which marches quickly across country, making the surfaces of the ponds boil up with great splashing drops and coming on like a screen of watery rods let down from the sky.

In the course of periods of excessive rainfall, and especially in the latter part of the monsoon when vegetation has become very rampant, much damage often arises in gardens owing to the fall of great masses of creepers and the breaking of large boughs which can no longer sustain the burden of their drenched foliage. *Cassia siamea* is a tree which is particularly apt to suffer in such circumstances because of the friable nature of wood and its

peculiar habit of branching. Almost all the main boughs follow an ascending course, rising at very acute angles from the stem, and leaving deep narrow hollows between the opposing surfaces of bark in which accumulations of water and débris gather and form starting-points for processes of decay, which gradually eat their way downwards until the resistance of the surrounding tissues is no longer able to overcome any unwonted strain. So much is this the case that it is always well to avoid taking shelter under these trees when caught in the open by a sudden shower. Another tree which is particularly apt to suffer at such times is the pipal (*Ficus religiosa*), partly because of the excessive leverage of its far-reaching horizontal limbs, and partly on account of the fact that these are so often attacked by burrowing grubs who eat out great tunnels in the wood.

Towards the end of August distinct signs of the advent of autumn begin to appear. On each successive evening the splendours of afterglow steadily increase; the great crickets set up their shrilling concerts in the dusk; kites begin to show thoughts of building; and presently the earliest of the winter migrants appear. A strange, subtle change takes place in the quality of the light, and, long before there are any other atmospheric warnings of the approach of winter, the landscape is every morning steeped in a peculiar yellow radiance that occasions a sense of unrest and longing for change of locality. Now and then, too, there comes a morning which in everything but temperature might be one in mid-winter, with a

crystallinely clear pale blue sky, golden sunshine—and even fitful breathings of northerly air, stirring the shrubs from which the harsh chattering of newly arrived brown shrikes resounds, startling the wavering clouds of butterflies over the crowded odorous blooms of the Divi-divis, and heaving the foam of salmon-pink flowers on the Kleinhovias. Stray white cloudlets drift high overhead ; scores of kites sweep about whistling and mewing ; a tree-pie occasionally makes a furtive tour through the trees uttering all manner of queer sounds ; troops of babblers gabble noisily among the dead leaves ; tailor-birds call aloud ; and the usual babel of talk from the crows goes ceaselessly on. Brown hornets hurry by on their raids ; a few wagtails pace along over the paths, every now and then interrupting their dainty leisurely progress to make sudden headlong darts after attractive insects ; clouds of dragon-flies swoop and circle over all the open spaces ; the trees are bathed in golden light and brave in the tints of fading and newly unfolded leaves ; and stately silver plumes shoot up from all the tufts of giant grasses which clothe the surface of waste land.

The decreasing moisture of the air and the onset of cooler nights occasion a renewed fall of leaves and the appearance of a fresh crop of shoots on many trees. The country almonds once more change their dresses and produce a third set of flowers. Many of them clothe themselves in young shoots without taking the trouble to throw off any great number of the leaves which appeared at the beginning of the rainy season, but others become

for a short time almost as bare as they were in spring or late June. The pipals are again gay with rosy and purple tufts; the Kleinhovias, which have reserved their blooming until now, suddenly break out into a froth of bright pink; the tamarisks become even more beautiful than usual, clothed in an overgrowth of bright green feathery sprays; and all the cork trees (*Millingtonia hortensis*) begin to show hanging clusters of long-tubed, starry white flowers, sprinkled over the thick masses of foliage like light falls of snow and filling the air at night with delicious honey-sweet fragrance.

One very special charm of autumn in Bengal lies in the strange mingling of afterglow and moonlight which sometimes is present. It is not easy to forget the sight of a great white moon hanging in an eastern sky dappled over with little rosy clouds; and the struggle of the lights and shadows cast by a rising moon in the east and a brilliant glow on the western horizon has an almost supernatural mystery about it; all the trees to the west acquire a new and strange look when lighted by a bright moon and backed by a sky flaming in the strongest red and yellow.

At this time of year, too, even the commonest sights and sounds tend to acquire a special value, for the lucid purity of the freshly washed air during the intervals between drenching showers serves to lend an unwonted accentuation to many tender tints and tones which in other circumstances are very likely to escape notice. The air at sundown is doubtless often heavy and stagnant, but



many delightful evenings may be spent, especially in places, like the Botanic Garden at Shibpur, abutting on the river (Plate XIV.). There the voices of the brimming and hurrying water grow as the dusk deepens until the air is full of liquid musical sounds. The sky may very likely be clothed in soft veils of cloud save where the full white moon seems to clear a path bounded by strangely ruddy vapour; little lambent tongues of splendour leap upon the ruffled surfaces of the stream, or twinkle among the polished masses of foliage; to the west a dim grey level with paler streaks and glossy patches of blackness marks the course of the river, whilst eastwards all the reaches are alive with lines and scattered points of light. Now and then the shadow of a flying fox or an owl sweeps over the surface of the water, and fireflies flash and sparkle amid the blackness of trees overhanging the banks. The sounds of the river wax and wane in a mysterious way, the eddies seeming every now and then to boil up suddenly and then slowly subside until the sweetly toned lapping and "liquid wash" of the tide on all the projecting points of the shore once more become clearly audible. The moonlight tells in very different ways on various kinds of foliage; every pipal leaf which it strikes becomes a blinding patch of silver, whilst the finely divided plumes of the Casuarinas are transfigured into ghostly veils woven out of innumerable little lights and shadows. As the night goes on the sky gradually clears; the moon becomes surrounded by a great space in which no stars are visible, and so strong is the light that



PLATE XIV.—ON THE BANK OF THE HUGLI.



even far out towards the horizon only the larger constellations appear.

Extensive floods are specially likely to take place towards the close of the rainy season, because already brimming rivers are then met by exceptionally high tides coming up from the Bay of Bengal, and also because all the surrounding country has been saturated by the heavy rain of the preceding weeks. Under such conditions any continued wet weather is enough to lay large tracts of land under water for many days. In some places the inundations are intermittent, rising and falling with each successive flood- and ebb-tide, but in others the lie of the land is such as to favour continuous accumulation of water and the gradual formation of wide lakes in which trees stand knee-deep and shrubs bathe their branches in broad sheets of water, steely grey or tawny with mud by day and glowing in fiery reflections at sunset and during the afterglow. Now is the time to gather an abundant harvest of snakes, for they are flooded out of all the lower levels and forced to assemble in troops on the islands and banks which remain more or less dry, or at all events above the reach of the water.

As autumn advances the omens of a change of season multiply and become day by day more and more decided. The bull-frogs gradually fall dumb ; the concerts of great crickets diminish in intensity every successive evening and finally die out ; migrant birds arrive in steadily increasing numbers from the north : the adjutants take wing for their nesting-haunts ; the strange, laughing calls of little



grey foxes begin to sound out nightly in all open spaces of waste land; and then, on some happy morning towards the end of October or the beginning of November, one wakes up to the fact that a keen dry breeze is streaming steadily in from the north and that the longed-for cold weather has really set in.

## CHAPTER XIV

### “THE COLD WEATHER”

Diu werlt was gelf, röt unde blâ,  
grûen, in dem walde und anderswâ  
kleine vogelesungen dâ.

WALTHER VON DER VOGELWEIDE.

And now there rose a thick white mist that silently  
Folded the fair earth in a funeral shroud.

JEAN INGELOW.

JUST at the beginning of winter the mornings are apt to be foggy owing to the preceding excess of atmospheric humidity, and to the wide range of temperature during the course of each period of twenty-four hours. The generally diffused dampness of the country provides for the development of widely spread haze, and the ponds become steaming cauldrons which pour out thick clouds of mist all through the course of every cold night. The sunshine by day is still strong enough to warm the water so much that it remains at night much hotter than the surrounding land and air are when exposed to free radiation, and consequently, all through the later hours of darkness and well on into the morning, wreaths of dense white vapour rise out of all the hollows, and drift away in low-lying banks of cloud. These are often so sharply defined above that the heads and

shoulders of riders may be seen travelling along over them as though they were entirely independent of bodies or horses. Under such conditions, too, the tops of trees often seem to be floating freely in the sunshine lighting the surface of a soft white cloud. Now and then more general fogs occur; rising to higher levels in the air, drifting in great clouds from the river, and usually setting in at times when cold northerly breezes return after they have been temporarily replaced by moist, southerly ones. Under the influence of thick mist all the spiders' webs are glorified by adherent drops of water, and sometimes injured by the loads which they are called upon to bear; and, at the same time, the foliage of the *Casuarinas* acquires an adventitious beauty because all the projecting joints in the drooping needles form sites at which great shining drops collect, and go on growing until they become too heavy to hold up any longer and rush headlong downwards, sweeping up all those below them as they go, and finally falling with sounding splashes on the moist ground beneath.

Evening after evening the afterglows gain in strength, and, whilst they last, everything acquires an almost unearthly splendour; all the colours of common garden flowers shine out in unwonted richness, and even the *tadi*-palms, which in daylight look so vulgarly stiff and pallid, lose their raw tints and stand up painted in warm tones, or stately in sombre magnificence against a flaming background of red and orange sky. It is an un-failing source of joy to watch the dying day to its

close from the top of a lofty terraced roof. Low down in the west there are often a few stratified clouds which just after sunset become painted in deep lavender, save where their lower edges glow in the brightest carmine. Higher up there may be some thin veils of vapour spread out over a surface which passes from strong Indian red below, through orange and saffron into the clear pale grey of the upper sky. Presently the show of colour creeps slowly downwards, deepening in tone as it descends. Fine clouds of blue smoke drift from the roofs of native huts and spread out horizontally through the still air, and here and there the cold grey glint of a pond shines out of the growing dusk. Kites come in to roost, drifting along on wide-spread wings and whistling shrilly as they go to join those who are already seated motionless on the tops of palms and other lofty trees. Brain-fever birds are still practising scales amid the thick heaps of foliage, and now and then brown shrikes chatter noisily from the shrubberies. Bats begin to scuffle out of their hiding-places, and flutter out in constantly growing numbers just when the afterglow is kindling up in the west. When the last faint traces of the sunset-colours are on the point of dying out, the western sky flushes up anew into red and orange, and all the clouds are once more glorified by more diffused but even richer tints than they had a short time before. Very often the upper sky becomes dappled over with little clouds set on a background of tender blue, and, when there is a moon, the cross lights become more and more bewitching. Great



stars begin to sparkle out here and there; the spotted owlets suddenly think it time to chatter noisily; a belated magpie-robin may persist in singing cheerfully; the jackals awake and cry aloud; now and then the peculiar clucking notes of wall-geckos may be heard; and presently the nocturnal chorus of frogs and insects sets in, although in a somewhat subdued fashion at this time of year. Then the afterglow begins slowly to fade, and gradually dies out leaving the sky to the moon, the stars, and a few patches of fleecy clouds.

There is always something very impressive in the pause which separates sunset and afterglow. In the Himalaya the effect is enhanced by the coincident deathly pallor which covers all the snow-clad heights, but, even in the low country, the gradual dying out and seemingly causeless resurrection of vivid colouring is very striking. Now and then, too, individual shows of quite exceptional magnificence occur, like one which once glorified a voyage down the Hugli with a sky thickly clothed in little patches of cloud glowing in the purest rose-colour against a backing of the brightest blue. The period which elapses between the descent of the sun beneath the horizon and the first sign of kindling afterglow usually amounts to at least a quarter of an hour, so that there is full time for the almost complete disappearance of the one illumination before the other sets in. In India I have never observed any extraordinarily rapid incidence of darkness after sunset, and I have often been disposed to question

whether the statements regarding the normal occurrence of such an event in tropical regions may not, in some measure at least, be founded on imperfect appreciation of the degree to which afterglow effects manifest themselves there. In India, darkness certainly does follow the disappearance of the light of afterglow very quickly, but the absence of prolonged twilight is not owing to any exceptionally rapid arrival of darkness after sunset, but to protracted illumination depending on highly developed afterglows. The normal sequence of events which is present in circumstances favouring strong afterglow is, that after the glories of sunset-light have almost completely died out, early effects of dusk prevail for a time; and it is only after they have done so for a very appreciable period that true afterglow begins to light up, growing gradually to its maximum and then fading out and being quickly followed by darkness.

There surely can be very few shows of afterglow finer than those to be seen from the Valley of Nipal or its bounding hills. A long line of magnificent snowy summits fringes the horizon for about one-third of its extent, and forms a range of such exceptional length from east to west that sunset and afterglow may be seen to follow one another in solemn procession along its course. So far-reaching is the track that, at a time when the western peaks are still glowing in the last rays of sunset, those in the extreme east are already beginning to shine mysteriously as though lighted from within; whilst in all the intervening space the snowy slopes and dark rocks remain

standing out hard and clear in the strange, ghastly chill which they acquire immediately after the descent of the sun beneath the horizon.

The effects of afterglow, whether on clouds or hills, are to be seen during a great part of the year in India with a constancy and intensity almost inconceivable in Europe, and the circumstances in which they appear certainly favour the belief that they are mainly of refractive origin. Afterglow was at one time accounted for simply as the result of reflection by the western sky of rays of light striking upwards from below the horizon, but more recently it has been shown that, when the lower layers of the atmosphere are strongly heated during the day, the rays of the descending sun must undergo so much upward deflection that for some time before the occurrence of true sunset they will cease to fall upon low-lying clouds or hill summits which they would otherwise reach. But, if under such conditions a rapid fall of temperature sets in in connection with elevation above the general surface, the deflection will diminish, and with this, "brightness falls from the air," although not exactly in the sense of the song in "Summer's Last Will and Testament," and clouds and hill-tops from which it had vanished will once more light up into vivid radiance. The older theory seems incapable of accounting for the markedly seasonal distribution of afterglows in India, where they are practically absent during the whole course of the hot weather and the earlier part of the rains, and then undergo steadily progressive development until the middle of winter. There is no evidence

of the occurrence of any corresponding fluctuations in the reflective properties of the sky during like periods, but there can be no question in regard to the presence of corresponding fluctuations in the range of temperature, and that the degree of evolution of afterglow runs closely parallel with the degree to which rapid and relatively great fall of temperature attends the descent of the sun towards and beneath the horizon.

Owing to the fact that in tropical India there are many temptations even during the cold weather to behave like the virtuous woman of Scripture and "rise while it is yet night," or at least to do so, like La Fontaine when he got up in order to study the ways of rabbits, "*que n'étant plus nuit, il n'est plus encor jour,*" Anglo-Indians in Lower Bengal have frequent opportunities of watching the details of dawn and sunrise. The first of these to appear is the aurora, which suffuses the eastern sky with colour, faintly pink at first, but quickly spreading upwards and deepening into an "awful rose." This gradually fades out, and is replaced by a pallid greyness, which lasts for a short time. Then a faint golden light begins to shine upwards, catching the edges of any low-lying clouds, and rising in seeming pulsations of steadily increasing brightness, whilst at the same time a renewed, but only faint flush of pink runs out along the horizon and melts off above into the pearly grey of the upper sky as the disc of the sun begins to show. The effects of dawn, like those of sunset and afterglow, are specially impressive in the hills, where all the great snowy summits stand out in delicate



colours, and seem to float on the surface of a firmament of white clouds steaming up from the warm depths of the valleys below. One very memorable experience of the early morning is the sight of birds flying aloft until they are suddenly transfigured by the rays of slanting sunshine at a time when everything below is still wrapped in twilight.

The later hours of winter mornings are quite delightful, almost as alluring as those of the evenings, and towards the end of the season they acquire a special charm from the varied and vivid colours of the fading foliage on many different kinds of trees. The grass is drenched in dew, and flecked by shining white patches where the slanting light strikes upon the closely meshed webs of burrowing spiders. Long shadows fall across the open spaces from trees to the east, over which the sun has not yet risen; the Siris-trees are already almost bare of leaves, but are heavily loaded by large yellow pods, and show delicate tracteries of twigs against a pale blue sky; the stalks of the great fans crowning the tadi-palms look as though they had been washed over with gold where the sunshine falls upon them, and the fading fronds below are brave in varied tints of brown and ochre; where the light passes in beneath the overarching plumes of the Nipas rising out of the brown water of ponds and ditches, it strikes upon their curious large fruits, which curve over ready to fall into the flood as they ripen; some Sterculias are already leafless and crowned by stiff, ungainly sticks, but others are still clothed in dry,

brown, crumpled foliage, or are beginning to break into bloom. Birds are everywhere wide awake, and fill the air with their various notes; doves cry aloud on every side; tree-pies chatter and flute; wagtails race and pace over all the walks; bulbuls leap through the air with cheerful shouts; white-breasted kingfishers shriek and hurry by on flashing blue wings, and the strange, thrilling tones of great gurgals occasionally ring out from the tops of the trees; honeysuckers and ioras swarm around the flowering shrubs; parties of babblers riot over the heaps of fallen leaves; koils now and then advertise their presence to the nesting crows; a few corbies salute the rising sun with harsh cawings; king-crows sit about in pairs on the ends of boughs overhanging open spaces, talking ceaselessly and at intervals launching out into the air in pursuit of passing insects; tit-larks are busy among the long grass; and troops of swifts pursue their shrieking progress in and out around the palms to which their strange little nests are fastened.

It is perhaps on mornings like these that the mahogany-trees, which are always admirable, appear at their very best (Plate XV.). The finely divided foliage in its tints of warm brown and golden yellow contrasts with the cool grey of the bark on the great stems and larger boughs, while from projecting points numberless delicate geometrical spiders' webs hang over the paths, shining with transitory sparks and waves of light where they catch the sunshine as they swing gently to the breeze; and in addition to regular

webs, long, solitary threads hang down everywhere, waving slowly to and fro, and appearing and disappearing as the sunlight runs along them.

It is not every morning of late winter that braves it in glories like these, for, with the growing heat of the days and the coincident unsteadiness in the northerly breezes, conditions arise which once more favour the development of fogs. Sometimes the whole sky is completely covered by an even layer of dull grey cloud, and the air is unpleasantly raw and chill, although the thermometer affirms that it is really warmer than on a clear morning; sometimes the atmosphere seems to be uniformly stuffed with mist; and sometimes dense clouds cling close to the ground whilst everything a few feet above is bathed in the brightest sunshine. It is a strange new world that any one enters on going out of doors on a still morning into a generally diffused thick fog. The sky is lowered, and the landscape narrowed by a pale grey curtain; an air of mystery and expectancy pervades the most familiar environments; and even a small garden is transformed into a boundless domain full of endless possibilities.

The quantity of rain which falls during winter varies greatly in different years. As a rule there is no fall for some weeks after the wind has gone steadily into the north; but about Christmas, clouds very often gradually gather, and a day or two of wet weather is not uncommon. The occurrence of rain at this time is a matter of some importance; for a good heavy fall not only serves to clear the air and wash the grass and trees of the thick coating of dust which has begun to cover them,



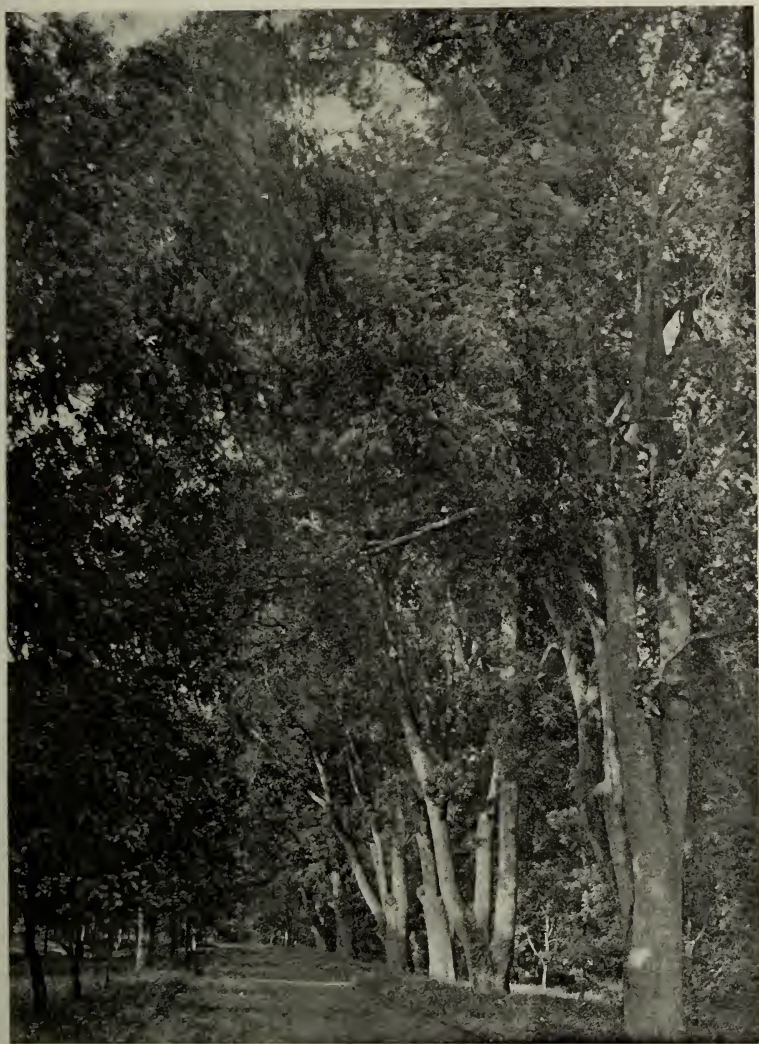


PLATE XV.—AN AVENUE OF MAHOGANIES.





but also secures a delay in the recurrence of unpleasant heat. Should there be no heavy rain at Christmas, and continued dry weather during the following weeks, the latter part of February is almost sure to be decidedly warm ; but with good Christmas-rain and a few heavy showers afterwards, the temperature remains very bearable until the middle of March. The occurrence of rain in the latter part of the season is usually preceded by oppressive weather, with southerly breezes, foggy nights, and a gradually increasing growth of clouds in the afternoons. Then comes a morning, on which there is very likely no fog, but which is warm and still enough to encourage the copper-smith barbets to begin to call freely. The sky may be quite clear ; but should the brain-fever birds leave off their name-calls in favour of scales, the speedy onset of rain may be hopefully looked for. Clouds gather by degrees during the course of the day, at first piling themselves up in the north, and then towards evening spreading out over the whole sky. Thunder and lightning soon follow, and presently the sound of rushing rain and the smell of moist earth fill the air. It is noteworthy how very quickly various kinds of insects appreciate the approach and arrival of rain ; as the darkness deepens and before more than a few scattered drops have fallen, the nocturnal choruses of cicadas and crickets, which have been entirely suppressed during the preceding drought, break out in full force, and at the same time hosts of fireflies swarm up as though germinating out of the dry and dusty soil. The storms at this time

of year are, as a rule, unattended by any violent wind, but in some seasons, from the very outset, they have more or less the features characteristic of the nor'-westers of the hot weather.

It is, according to a British standard, hardly ever really cold in Calcutta, but there are often nights in winter when the thermometer goes down into the forties, and even when it stands considerably higher the persistent dampness of the air gives rise to a very decided sense of chill. So much is this the case that small fires are often very welcome in the evening, and the joy of once more seeing them is so great that there is a strong temptation to continue them long after they have become objects to be admired from a respectful distance. During cold weather the chill naturally reaches its maximum just about sunrise, and any one who goes abroad then is sure to see rows of small children and village dogs sitting in patient expectation beneath walls facing to the east ; indeed, when the orientation of a place is unknown, it may always be readily ascertained during the cold weather by the direction in which the dogs' noses point in the early morning. This is a detail in canine life-history which can be studied with dispassionate interest ; but the fact that the coldness of the nights and the excessive brightness of the moonlight in winter serve as most efficient stimulants to the nocturnal concerts of the dogs in all the native villages is not a matter for philosophic appreciation. There are few more trying experiences during the long sleepless hours of darkness incident on an attack of fever, than the nervous irritation caused by

the incessant and melancholy howling and baying of hosts of pariah dogs.

It is curious to observe how very little most birds seem to suffer from the cold. A few, such as the common pond-herons, appear to be rendered somewhat sluggish, and are inclined to linger on in their roosts even after the morning sunshine has reached them for some time, and the copper-smith barbets are at once struck dumb whenever the temperature of the air falls below 70° F., but most species seem to be nowise affected : crows and mynas persist in taking evening baths even on the coldest nights ; and at sunrise, the honeysuckers and other small birds bathe furiously among the dew-laden masses of foliage on the shrubs. All through the course of winter, except on cloudy nights, dew is so lavishly deposited that everything is thoroughly drenched in the early morning, and dogs, although they do not as a rule bathe in the soaking grass, seem to think it a great luxury to lick up the stores of liquid which are everywhere provided by it and other kinds of undergrowth. The different sorts of grass in the turf of lawns vary curiously in respect to the quantity of dew which they carry, so that, in the early morning, it is usually easy to make out the areas which they occupy. This is particularly conspicuous in regard to the common *dhūb* and *ūlū* grasses ; for every patch of the former shines with silvery lustre owing to adherent drops, whilst the spaces covered by the latter are evenly and vividly green because the blades are varnished by continuous, thin layers of moisture. The shows of dew are, however, by



no means confined to the lawns. Some of the most striking are those on the spiders' webs; almost every mass of finely divided foliage shines in borrowed radiance; the tamarisks look as though they were sprinkled with diamond dust; and all the drooping needles of the Casuarinas are splendid in great drops. Out over the ponds, too, great jewels of water sleep and slide about on the grey-green surfaces of the leaves of Nelumbium, and miniature rainbows show where the innumerable wet points of fronds of azolla catch the sloping sunshine.

Towards the end of winter many different kinds of trees acquire a very special value in the landscape owing to the brilliant colouring of their fading foliage or crowded bloom. Country almonds (*Terminalia Catappa*) are truly noble trees at any time; their trunks, even when deformed by huge tumours caused by the presence of parasitic fungi in the bark, are magnificently picturesque (Plate XVI.), and their boughs when in full leaf form superb tiers of light and shade; but now they become quite surprisingly splendid, especially in seasons in which there has been enough rain to prevent the leaves from drying up too rapidly. As they fade they pass through a whole series of bright tints ranging from pale yellow, through orange and carmine (Plate X.) to a full strong purple or madder-brown; and the effects produced by oblique sunshine striking on, and particularly striking through, the leaves can only be likened to those developed by the fragments of coloured glass in the *shemsīya* windows in old Saracenic tombs. All around there are shifting shows of brilliant

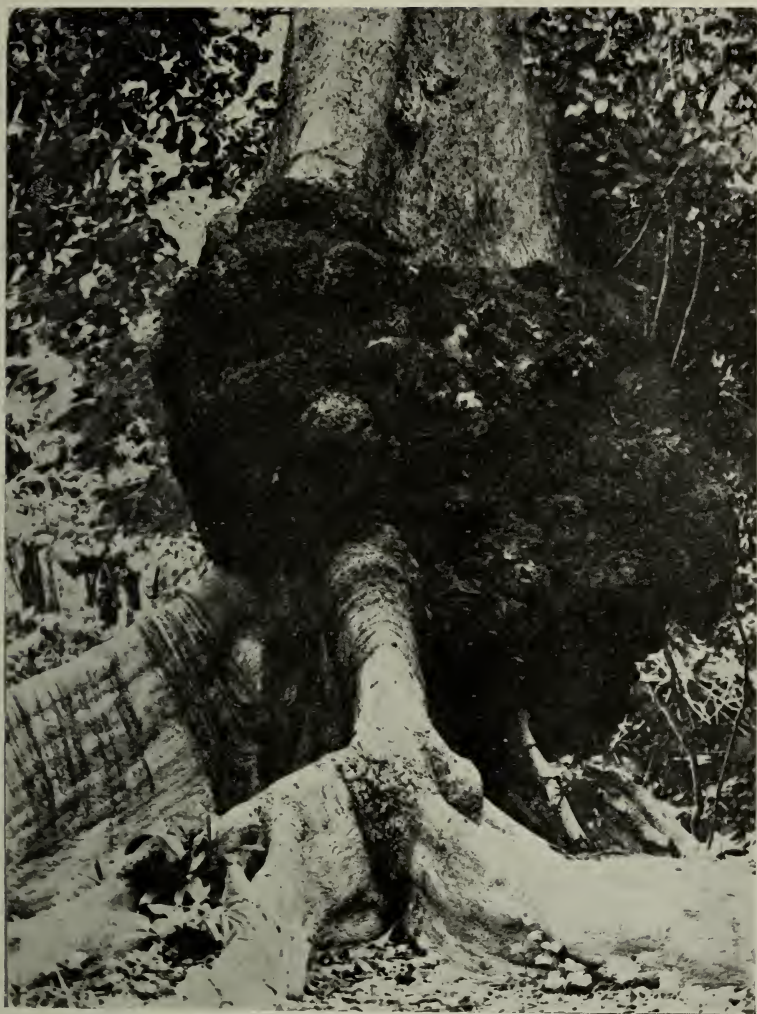


PLATE XVI.—STEM OF A COUNTRY-ALMOND DEFORMED BY FUNGI.



colour, changing day by day and unattended by regretful anticipation of any impending period of bareness and wintry death, for, even before the last flaming leaves have fallen, a mist of tender green begins to break out all over the branches on which crowds of buds are swelling and unfolding their closely packed blades.

At the same time a series of transformation-scenes are played on all the silk-cotton trees. Towards the end of December the leaves of the common semals (*Bombax malabaricum*) turn bright yellow and presently shower down, leaving the gouty twigs thickly beset with black points representing flower-buds; and, by the end of January, the branches are almost bare and the first great blooms opening out. The flowers (Plates VIII., X.) are truly magnificent objects with thick cartilaginous calyces, painted in green and madder-brown, and bearing corollas four or five inches in diameter and built up of petals curved boldly outwards, glowing in varied shades of ochre and vermilion, and uniting beneath to form a deep cup containing hosts of stamens and a long stylar column capped by purplish brown divergent stigmas. A tree in full bloom forms a superb ornament to any landscape, especially when slanting sunlight projects the glowing masses of flowers and the silvery grey bark of the branches and grandly buttressed stem against a background of cloudless blue sky; nothing short of a Japanese drawing of blossoming peach-trees can give any idea of the purity and brilliance of the colouring. The young calyces at first form continuous, purplish brown, polished hoods over the



petals and then split above into three convex lobes surrounding the brim of a deep cup. This is so dense and resistant in texture as to form a secure receptacle in which large quantities of fluid, consisting partly of secretions furnished by the flowers and partly of the dew which drains down along the smooth surfaces of the petals, collect to provide stores of a liquor which proves most alluring to many birds and insects and even to some arboreal mammals. Whilst it lies soaking the neighbouring tissues it seems to undergo a certain amount of fermentation, acquiring a faintly acid flavour and, to judge from the behaviour of the birds who partake of it, decidedly intoxicant properties. Its attractions are sure to bring numbers of crows to have a nip before setting out on the day's mischief; mynas of various sorts throng the branches and squabble for the best seats; barbets, bulbuls and orioles look in; king-crows and koils often yield to the temptation; and even woodpeckers sometimes join the throng, although it is doubtful whether they do so from a vicious love for strong drink or really are virtuous birds attracted by the stores of drowned insects which form a deposit in the bottoms of the cups. In addition to all the birds, palm-squirrels join in the revel, darting about from place to place, flirting their feathery grey tails from side to side, and chattering noisily in angry competition for the best places. The ceaseless hubbub and movement, the torrents of different notes, and the frequent squabbling convert the trees into disorderly fairs until the supply of drink has been temporarily exhausted under the continued demands of the

topers and the growing energy of the sunshine ; and, during all the time that the debauch goes on, flowers are constantly being broken off to fall in a curiously screwing course and strike the ground with soft thuds.

The scene is certainly one of the wildest dissipation, but the sense of moral disapprobation excited in an onlooker is tempered by the knowledge that the drinkers are doing something beyond merely enjoying themselves ; for there can be no question that they are most efficient agents in securing the cross-fertilisation of the flowers. Should they be watched closely through a strong glass it will be seen that, whilst bending over to thrust their beaks into the lower parts of the cups, the birds constantly smear their crowns with pollen from the anthers, so that, on visiting other blooms, they must almost inevitably transfer some of it to the projecting stigmas. It seems probable that it is only because of the lavish pollination which is effected in this way that the trees are usually able to produce very large crops of fertile fruits in spite of the fact that great numbers of their flowers fall in consequence of the rough way in which the process is conducted.

These great drinking bouts take place in the early morning when the supply of liquid in the flowers is greatest owing to the dew of the preceding night ; but, all throughout the course of the day, casual visitors look in in quest of a drink, and towards sunset there is often a considerable gathering of dissipated birds who regard a nightcap with favour. As the flowers age, and long before they

show any signs of fading, their colouring becomes paler than it was at first, and now it is that the anthers mature. The stamens are disposed in two quite distinct groups, one encircling the stylar column, and the other diverging so as to come into close relation to the inner surface of the corolla (Plate X.). In the inner group there are stamens of two distinct forms, the greater number being short and bearing simple anthers which do not reach to the level of the stigmas, and the rest, five in number, very much larger and with filaments each of which divides into two branches capped by large twisted anthers (Plate X.). When a flower first opens, the five lobes of the stigma are erect and closely applied to one another so as to project above the level of the anthers of the neighbouring great stamens, but they afterwards diverge and curve outwards so that, as the large stamens at the same time grow upwards, the individual stigmatic lobes come to protrude between the filaments. When birds are drinking out of the lower part of the corolline cups, they thrust their beaks down between the two groups of stamens, and, in doing so, dust the tops of their heads with pollen from the anthers of the large ones in the inner group, so that when they go on to another flower they are almost sure to wipe some of it off upon the projecting lobes of the stigma. The flowers are very attractive to many insects, and specially to a great bee with a thorax of bright golden yellow contrasting with the metallic green tints of the abdomen and wings; but it is unlikely that they exert any important influence on the occurrence





PLATE XVII.—CONE OF A SCREW-PINE.





of pollination, for the space between the two groups of stamens is wide enough to allow of their reaching the lower part of the corolline cup without coming in contact with either of them or the stigmatic surfaces.

A few weeks later almost all the flowers have fallen, and, at the same time, the trees become clothed in a flush of fresh young leaves and a thick crop of fat green capsules which soon begin to split and discharge their contents. The seeds are embedded in long silky white hairs, tufts of which spread out to form parachutes that drift about through the air, diffusing their burdens abroad, and eventually sinking with them to accumulate in unsightly heaps on lawns, or drift to and fro over the surfaces of ponds. The hairs of which the cotton is composed are smooth, even tubes filled with air, and, although not of a nature to yield good thread, are often used to form the stuffing of cushions and quilts.

About the middle of winter the great pineapple-like cones of the screw-pines (Plate XVII.) begin to ripen. When mature they have a fine orange or reddish hue, and add greatly to the beauty of the plants as they shine out amid the heavy masses of long, serrated, deep green leaves. Like the cones of Cycads (Plate XIII.), they are quite unsuited for purposes of house decoration, owing to their heavy, unpleasant smell; but, as they give off no irritant pollen, it is headache and not violent sneezing which is likely to attend their introduction into rooms. In attempting to examine them closely whilst still hanging, it is always well to be cautious

to avoid injury from the savage armature of the surrounding leaves (Plate XVIII.), for scratches from this are sometimes as venomous as those inflicted by the spines of Agaves often are. The toxic properties of the leaves in both cases are probably owing, not to the presence of any intrinsic venoms manufactured by the plants, but to that of extraneous materials which are, of course, very apt to accumulate on the surfaces of tissues that persist for months, or even years, exposed to contact with the air and any foreign bodies contained in it or derived from other sources. Be that as it may, I can certainly witness to the venomous properties of the spines of screw-pines from unpleasant personal experience. I once received a slight scratch which presently served as the starting-point of a patch of erythematous inflammation, bordered by a line of small vesicles and spreading so rapidly that it presently covered the greater part of the back of the injured hand. I am hardly likely to forget the adventure; for, after having vainly attempted to arrest the disease by gentler means, I finally poured a lot of liniment of iodine over the inflamed area—a treatment which was doubtless most effective, but which caused me to spend the rest of the afternoon walking up and down the verandah in the agony incident on its heroic nature.

Very few tropical trees when leafless have any of the charm characterising most deciduous ones in temperate regions whilst in a like condition. In by far the greater number of them the individual leaves are so large as to call for the presence of

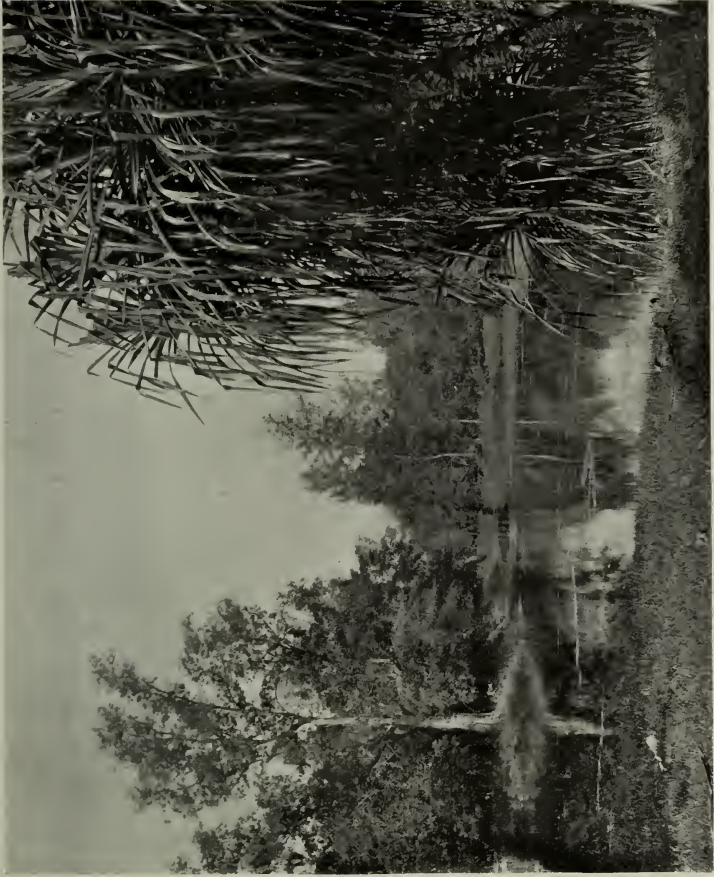


PLATE XVIII.—A MASS OF SCREW-PINE.





stout supports; and therefore, on falling, they leave behind no delicate tracery of finely divided twigs, but merely an assemblage of gouty and stiffly curved sticks like those which disfigure the horse-chestnuts and ashes of English woods in winter. There are, however, a few trees common in the plains of India which, even when quite bare, are wonderfully beautiful: a fine old pipal rivals any great oak in the magnificent reach of its boughs and the intricate network of its smaller branches and twigs (Plate XIX.); a leafless sisu (*Dalbergia Sissoo*) is a perfect miracle of grace; and some trees, such as tamarinds, which hardly ever display their naked beauties, may occasionally, under the influence of prolonged drought, show how admirable they really are.

As the days lengthen and the sunshine waxes in strength, signs of the approach of the hot weather appear more and more conspicuously. The treasured European annuals, which have glorified the flower-beds for many weeks, begin to have a poverty-stricken look, however carefully tended and watered they may be; their foliage acquires an unhappy aspect, and their blooms steadily diminish in size and lose their brilliant colours. The sides of the highways lie deep in dust, and are gradually clothed by the whitish-green acanthus-like leaves of Mexican poppies; more and more trees begin to glow in the brilliant tints of fading leaves, and then to stand out in various stages of undress; the sun burns up more and more fiercely each successive morning; the grass on the lawns, in spite of all the drenching dews, takes on an

ochreous hue, and begins to show white plumes of flowering *ūlū* ; the afterglows diminish in splendour ; the sky day by day loses its clear blue, and is tarnished by an ochreous haze as more and more dust gathers in the air ; and at length there comes a time when there can no longer be any question that the hot weather has arrived, and the season for closed doors and windows, patience and pankhas, has fairly set in.

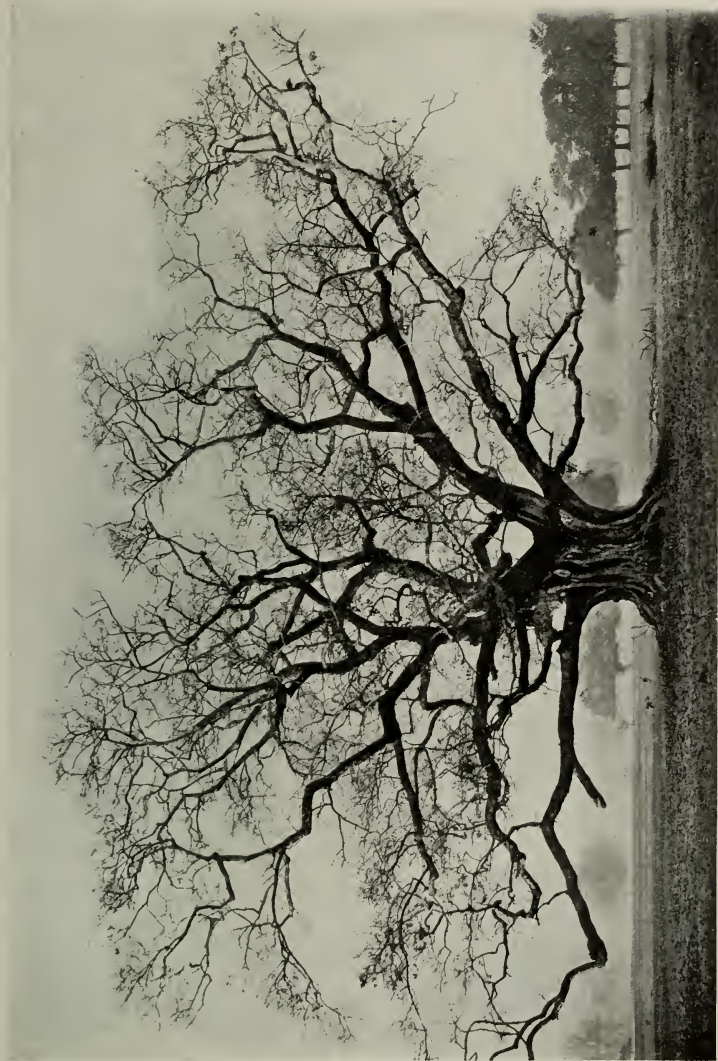


PLATE XIX.—A PIPAL IN WINTER.





## CHAPTER XV

### THE PONDS OF INDIAN GARDENS

O that I now, I too were  
By deep wells and water-floods.

SWINBURNE.

Or swim in lucid shallows just  
Eluding water-lily leaves,  
An inch from Death's black fingers, thrust  
To lock you, whom release he must.

BROWNING.

ONE of the most attractive features of gardens in Calcutta is that, owing to the low and swampy nature of the land, they so often contain large ponds; indeed, there are very few of any size which do not either contain, or abut upon, one or more of them (Plate XX.). At almost every time of year they present many alluring characters, but it is towards the end of the rainy season that they are perhaps at their very best, for then the water brims up to the lips of the grassy banks and is of delightful purity and coolness. At evening their glassy surfaces are painted over with images of the blue of the upper sky and the rose and gold of scattered clouds lighted up by sunset or after-glow, whilst all round the margins of the water there are broad green fringes of reflections of the neighbouring trees. In and about the water there is a very world of wonders. Submerged weeds form dense

forests, traversed by open glades, and full of tangled brakes and thickets. Diverse and strange beings wander about in the jungle; gallant little warriors, in the shape of rainbow-fish, clad in shining armour of green, ruddy brown and bright azure, glide gently about or tilt fiercely at one another with cruel black pikes; throngs of minute, fairy-like creatures, dressed in brown and gold, hover restlessly from place to place, attended by one or two sluggish and peaceable giants of dark complexion: silvery shining points discover the presence of small fish swimming close to the surface, and so quietly coloured and gentle in their movements that they might readily escape notice, were it not that each of them carries a tell-tale white spot on its head; huge leviathans lurk in the recesses of the woods, and occasionally issue forth carrying destruction with them; and aloft, over the surface of the water, gentle ghosts, clad in the gayest colours, move quietly about among the projecting grasses and over the leaves of lilies and other floating verdure; while, somewhat higher up and in the clear air, monstrous dragons sweep and rush about and savage brown marauders prowl from place to place in quest of prey.

The open water is bordered by broad bands of varied weeds. Tall grasses shoot up plumes of inflorescence; the varnished, leathery leaves and little white flowers of *Limnanthemum* spread out in sheets with interspaces crowded by the minute fronds of *Azolla* and duck-weeds; here and there great rafts, vivid green or wine colour and starred by white or crimson blooms, show where plants of



PLATE XX.—A POND, WITH THE STEM OF A SISU TO THE LEFT.





Nymphæas have established themselves ; whilst beneath the surface of the water are dense, erect tufts of the light green leaves of *Ottelia* surrounding strange white flowers from which streams of large bubbles constantly ascend, because, for the time being, almost all the gaseous excretion of the plants escapes at the base of the corollas and converts them into miniature diving-bells, within which the stamens mature and discharge their pollen free from any risk of contact with water until it has reached the stigmatic surfaces and germinated there. Pond-herons lurk and wade in the shallows, or show the snowy plumage of their wings as they flap slowly from one place to another ; kingfishers hover over the open water, or sit motionless and wary on projecting snags or overhanging boughs ; now and then a great fish suddenly heaves up and sends a wave spreading out over the surface, or a sinuous ripple marks the passage of a water-snake ; and occasionally a turtle floats stealthily up from the depths to lift his blunt snout and stony eyes out of the water, and then sink down as quietly as he rose.

Even the smallest pools are often wonderfully interesting and beautiful—microcosms including a strange and multiform fauna and flora ; aquatic spiders, dragon-flies, crickets, fish, frogs, and molluscs, together with hosts of water-plants, some with leaves floating on the surface of the water, others shooting up jungles of stems and blades above it, and still others remaining entirely beneath it to form a dense turf over the soil below. Whilst I write, a vision of one of these little pools rises

before me as it showed on a still autumnal morning nearly thirty years ago. In the foreground is an old rotting wooden fence, the bars falling from their supports, and brightly painted by crusts of brown, yellow, and silver-grey lichens. The water lies in the depths of cool shade cast over it by a cataract of delicate foliage descending from a neighbouring group of bambu, whose feathery plumes dip down into the brown liquid and over-arch caverns of gloom around the clustered canes. A solitary plant of *Nymphæa* shows a few of its snowy stars among the floating leaves; the steep banks are thickly clothed in long grass and great aroids; at one point a single leafless shoot projects from the thicket, and on this sits a small kingfisher, shining in blue and buff, and intently gazing downwards; and, on the farther side, the sloping sunshine strikes in to gild the tops of the bambus, whilst farther off wide levels of grass and great trees sleep in the light, and, as they recede into the distance, are softened by a faint blue haze.

As winter advances the fringes of *Limnanthemum* spread rapidly out over the surface of the water, and each successive morning are more and more thickly starred by little white flowers which rise into the air to unfold, and then, after they have been fertilised, are first bent over and finally deeply submerged owing to extreme curvature of their stalks. At this season, too, the sheets of *Azolla* attain their highest development, and in many places overspread wide spaces with continuous layers of minute fronds which are so closely packed together that many of them are forced

upwards by mutual pressure. Under the influence of continued exposure to strong sunshine they lose their original bright green colour and assume various soft tints of ochre or bronze ; and, after nights of drenching dew, the innumerable projecting points of their finely divided foliage are so thickly covered by drops of moisture that, when the oblique morning sunshine strikes athwart them, countless little rainbows wander hither and thither over the surface as it rises and falls under the impulse of passing breezes.

The various kinds of water-lilies which occur in the ponds of gardens in Lower Bengal can hardly fail to be objects of admiration and interest to every averagely intelligent inhabitant of the locality. It would be hard to say which of them is the most beautiful—*Nymphæa Lotus*, with pure white blooms ; *N. rubra*, with wine-coloured leaves and crimson flowers ; *N. stellata*, which shows its little blue, golden-hearted stars in mid-winter ; *Euryale ferox*, with magnificent rough, prickly leaves which rival those of *Victoria* in their extent ; or the great *Nelumbium*, which converts whole ponds into *Amitabha's* heavens of giant pink or white corollas rising up among forests of bluish green leaves.

*Nelumbium* certainly asserts itself with a superb audacity which is for a time justified by the glories of its glaucous foliage and roseate or white buds and flowers ; but for a great part of every year the ponds which it has usurped present but a sorry aspect, and are disfigured by tattered and decaying leaves and drying flower-heads



which suggest the result of a highly successful sowing of the seed of the spouts and roses of watering-cans. Two very distinct varieties of the plant are to be met with ; the first, and by far the commoner, bearing flowers of varying shades of pink and rose-madder, and the second glorying in great corollas of the purest white. In both cases the blooms give off a delicate ratafia-like odour which makes one feel quite sympathetic with the Egyptian ladies who are so often depicted as smelling at them during the course of their evening parties. Most of the flowers and all the curious obconical fruits stand well up above the water and the surrounding leaves, and the older blooms go on scattering coloured petals to sail about like gaily painted fairy boats in the creeks and channels between the crowding leaves. The flower-stalks are bright yellowish green, and the buds are of a like but paler tint, shading off above into pink or white tips, which when they begin to unfold disclose a rosy or pure white cavity containing a strange turbinate, pitted receptacle surrounded by bright yellow anthers. The leaves are originally of a uniform pallid glaucous green, but in many cases are soon blotched by patches of brown or yellow owing to partial decay. The epidermis of their upper surfaces is thickly clothed in projecting points which serve to prevent the direct contact of water, derived from rain or dew or washed in over the edges of the blades, with continuous areas of the tissues below. Even as it is, however, the presence of any large drop of water is a source of danger, for, should it lie at rest for any

appreciable length of time, it is apt to act as a burning-glass and originate injuries, which rapidly spread under the influence of saprophytic fungi or infusorial organisms and form irregular holes in the laminæ so as to give them a very disreputable and tattered look.

The young leaves begin to appear on the onset of summer, coming to the surface in the form of slender rods because the two halves of the blades are tightly rolled upwards and inwards to the middle line. Their growth and unfolding are very rapidly carried out; after the lapse of a few weeks flower-buds begin to appear, and for about two months the ponds are transformed into magnificent beds of flowers. The freshly expanded leaves are often seriously disfigured by the ravages of small grubs who burrow through the tissues between the two layers of epidermis, and leave these to dry up and shrivel into unsightly scars; and the mature foliage, in addition to injury from scalding connected with the action of the water which often accumulates upon it, is apt to become stunted and deformed when it rises above the level of the water in consequence of overcrowding or insufficient depth, and is then exposed to dry hot winds. When the flowering season is passed, the strange receptacles of the seeds, which the Vishnu Purana compares with Mount Meru on account of their having the form of inverted cones, become more and more conspicuous; and a little later, when the leaves have completely disappeared, they remain as the sole and grotesque index to the brave show which preceded their appearance.

A pond full of *Nelumbium* is a truly glorious object whilst the plants are in full bloom. Everywhere there are crowded masses of great round leaves ; some lying on the surface of the water, and either quite flat or with slightly raised, bronzy pink margins which catch the breeze and cause the smooth pallid discs to swim slowly round in curving lines ; and others rising into the air in the form of shallow bowls and cups of deep green and warm bronze. Above the thronging foliage rise countless flower-stalks bearing fat, oval buds, enormous pink or white corollas like great single pæonies, and here and there bright green, unripe fruits. Where any interspaces are left between the leaves, the water bears rafts of *Nymphæas* with crimson or pure white flowers, or patches of the curiously divided foliage of *Trapa natans*. Towards the margins of the pool there are broad belts of rushes and tall grass, and, immediately under the bank, the shallows are full of tangled webs of *Spirogyra* and other filamentous algæ. In the little creeks between the leaves of the lilies minute islands of the delicately sculptured fronds of *Azolla* drift slowly about in the gentle currents stirred by the breezes ; dragon-flies are everywhere, slipping in and out through the mazes of the aquatic jungle, hovering aloft in wavering troops, or rushing to and fro like destroying angels ; water-hens call loudly out of the coverts or step and run over the grassy slopes ; jacanas pace gently about on the floating leaves ; great stork-billed kingfishers perching on the tops of neighbouring trees occasionally utter their thrilling cries ; watchful alcedos sit quietly

on the lower boughs or the buds of the lilies ; and all the undergrowth on the banks is full of the notes of doves, barbets, tailor-birds, and babblers.

The common white and crimson water-lilies, *Nymphæa Lotus* and *Nymphæa rubra*, are such constant and conspicuous features in most ponds that it would hardly be necessary to make any special mention of them had it not been that they have often been described by systematic botanists as mere varieties of one and the same species ; but, as this is the case, and encouraged by Andrew Lang's sage remark that neither "creeds" nor "systems" can "make the maiden lilies bloom early or bloom late," I venture to give a few details showing how greatly the two plants differ in respect to many points in their life-histories.

*Nymphæa Lotus* is much the commoner form, and curious evidences of the wide diffusion of its seeds are afforded by the way in which it suddenly appears in isolated and purely temporary pools of water. A striking instance of such an event took place in the year 1871, when an exceptionally heavy and prolonged rainy season converted many of the shallow hollows in the wide grassy plain round Fort William into pools of standing water ; for, in the more persistent of these, and in sites which had for many years lain dry and covered by turf, white water-lilies came up and flowered freely. The phenomena in this case were certainly remarkable, but they were really only specially conspicuous examples of those which take place regularly every year when the onset of the rains raises the level of the water in permanent ponds. Very many of



these in and around Calcutta are mere localised accumulations of rain-water and are, therefore, subject to very considerable fluctuations in level. During the course of normal years the water rises to the very brim of the retaining banks in autumn, goes on almost steadily falling throughout the winter months, may be somewhat raised by heavy falls of rain attending the storms of the earlier part of summer, and finally sinks to its lowest level in the period immediately before the onset of the monsoon in June. The results of such fluctuations naturally vary greatly in individual cases, according to the nature of the banks and the depths of the spaces which they bound. In many shallow hollows the water entirely disappears for a time ; and in all those with shelving banks, even although complete drying up may not occur, the water shrinks so far as to leave broad fringes of exposed soil on which aquatic plants are, for the time being, almost entirely replaced by the grasses and weeds which permanently inhabit the surrounding land and speedily invade the fresh territory placed at their disposal. The details of the process are most interesting. As the water recedes, most of the aquatics simply throw up the sponge and either retire with it or remain stranded to die or pass into a dormant state. *Pistia stratiotes*, however, does not yield without a struggle, for when it finds it impossible any longer to swim freely about, it roots down into the mud of the shallows, and, long after these have been converted into dry ground, it continues to maintain a struggling and stunted existence among the land-weeds which have invaded

the warm, moist earth. The rafts of Lemna and Azolla have no such power of adaptation to change of environment, but rapidly wither and dry up, leaving deposits of brittle *débris*, including fruits and sporocarps which lie dormant until they are washed down by flooding showers or floated off as the level of the water rises and allows them to form the starting-points of a new generation.

On the occurrence of the first drenching down-pours of the monsoon, the margins of the water in the ponds become covered by flakes of floating rubbish in which it is usually easy to find such reproductive bodies long before any conspicuous signs of the presence of young plants can be recognised. Germination, however, very rapidly sets in, and within a short time a pond, which has been seemingly quite devoid of them, becomes fringed with patches of plants of Lemna and Azolla spreading out farther and farther over the surface and meeting together to form widely continuous sheets of verdure. The resurrection of the white water-lilies does not reveal itself quite so soon, but when it does occur it advances with surprising rapidity, especially in the case of seedling plants. Hardly has the level of the water begun to show any appreciable rise than numbers of small leaves force their way up amid the crowded stems of the flooded grass. Those which appear first are strangely unlike the large, mature ones which later in the season build up the floating carpets on which the flowers expand. They have short, erect stalks, bearing blades which, in place of forming deeply cleft discs, are divided into three sharply

pointed lobes, the central one being usually somewhat curved. Leaves of this character remain permanently beneath the surface of the water, but they are soon followed by a series of larger ones, the successive members of which show modifications of form causing progressive approximations to that of the mature foliage. The lobes become steadily shorter and broader, and at the same time the two lateral ones become more and more divergent, until their front edges form continuous lines with the sides of the central one, whilst their hinder margins come into close relation with one another. Leaves in this stage of development have an acutely sagittate outline, and in those which are developed later a progressively increasing expansion of the outer edges gradually leads the successive blades more and more to take on the rounded and somewhat sinuate outline of the mature ones. These changes in the form of the blades are accompanied by progressive increase in the length of the stalks, and, long before any mature leaves have appeared, the surface of the water bears sheets of young ones of transitional characters.

Shortly after the first appearance of any mature leaves, the plants begin to send up flower-buds, and fully opened blooms may often be met with in the third week of July. The exact date at which flowering begins is, however, naturally determined by that at which the monsoon sets in and also by the quantity of rain which immediately succeeds. After they have once begun to appear, the flowers rapidly increase in numbers and become



more and more abundant during the next three months. In October they are present in greatest profusion; during the course of November their numbers rapidly decrease; and by the end of December, not only have they entirely disappeared, but the foliage, as a rule, has died off so as to leave no visible traces of the plants. When the life-history of individual flowers is studied it appears that each of them remains more or less above water for a period of four days. On the first of these it appears as a bud just rising above the surface; on the second, it is half open and quite clear of the water; on the third it is fully open and still more elevated; on the fourth it remains fully expanded but rests on the surface; and on the following day it is quite submerged. The mature flowers remain tightly closed during the greater part of the day, and are wide open all through the night. Soon after eight o'clock in the morning they begin to close; about two hours later they are completely shut, and renewed expansion only takes place in the late dusk of the following evening.

Keeping these facts in mind we have now to consider the habits of *Nymphaea rubra*. Its behaviour is in many respects strangely unlike that of its relative. Whilst the plants of *Nymphaea Lotus* are in most cases mere annuals developed from seeds which germinate on the onset of the rainy season in June or July, those of *Nymphaea rubra* normally survive for at least two, and often for more years, and originate in seedlings which come up in February or March, a time at which



*Nymphaea Lotus* is normally entirely dormant. A second distinctive feature in *Nymphaea rubra* is, that where plants have established themselves their foliage is never entirely absent from the surface of the water and individual flowers may appear at any time of year, whereas ponds occupied by *Nymphaea Lotus* show no evidences of the fact during many successive months. The flowering seasons of the two plants are also quite distinct; for while the white flowers are most abundant between September and November, the red ones are so between November and January, the months of maximal abundance being October in one case and December in the other. The behaviour of the individual flowers in the two forms is strikingly unlike; for while the flowers of *Nymphaea Lotus* remain above water for four days and when mature are widely open during all the hours of darkness and firmly closed during the greater part of the day, those of *Nymphaea rubra* remain above water for five days, are tightly closed all through the night, and remain open for the greater part of the day. At the time when the flowers of the one plant are soundly asleep, those of the other are fully awake; and just when those of one are waking up for the day those of the other are closing.

That the two plants are closely alike in structure there can be no question, but in so far as their life-history is concerned they present hardly any points of agreement save that they are both aquatics, and often grow side by side in the same pond. Hybrids between them, even when they are

most closely associated, hardly ever seem to occur, and although this may be partly credited to the fact that the flowers in one case are essentially nocturnal and in the other diurnal in respect to expansion, there is a period every morning when both are simultaneously open, so that opportunities for crossing are by no means wanting. It may be a question whether physiologic peculiarities ought to be allowed any weight in determining specific differences; but should they be regarded as of any importance, these two *Nymphæas* certainly are not mere varieties of a single species.

Large plants of *Nymphæa rubra* are truly superb vegetables, especially when low sunlight strikes through the vivid crimson petals and falls upon the polished surfaces of great leaves surrounded by frills of raised points, and dyed in various shades of warm purple and bronzy green. Towards the end of the main season for flowering, and when normal blooms are rapidly diminishing in number, many strange bodies, seemingly representing abortive attempts at flowers, often appear among the foliage; sometimes in the form of structures exactly like isolated petals, and in other cases consisting of leaves in which one half of the blade has a petalline texture and colour whilst the other retains the wonted characters.

The beautiful little blue water-lily, *Nymphæa stellata*, although very common in the ditches and swamps of the open country, is comparatively rare as an inmate of ponds in gardens. When it is present it is a most charming and decorative guest, especially during mid-winter when its

shining leaves, strong green above and rich plum-colour below, spread out over the water in broad carpets spangled over with the pale blue petals and golden hearts of innumerable flowers.

*Euryale ferox* is a plant which no longer is native to the immediate neighbourhood of Calcutta, although the local deposits of peat afford unequivocal evidence that it must once have been so. It is, however, still very common in the swamps of Eastern Bengal, and when imported thence grows freely. The plants form very effective features in any large pond ; not on account of their flowers, for these are relatively small and under normal conditions permanently submerged, but owing to the superb size of the mature foliage and the wonderful beauty of the young leaves. These when they first appear above the water are folded together in a strangely complicated fashion, and gradually open out into enormous rounded sheets, lying very flat upon the surface and armed with formidable thorns. The flowers are pale blue and usually escape notice, unless when an exceptionally dry season lowers the level of the water so much that they are forced to appear on the surface.

One thing in connection with the ponds of Indian gardens which can hardly escape the notice of even the most careless observer is the strangely different appearance which the water presents at different times ; for while it sometimes seems to be perfectly clear, colourless, and transparent, there are occasions on which it is full of clouds, or covered by films or even thick mem-





PLATE XXI.—A POND CONTAINING *Nymphæa stellata*.





branes of varied and often brilliant colouring. Even when the water is clearest, even when it shows as a mere transparent medium through which the tangled growths of submerged weeds can be seen in minutest detail, or as a shining mirror reflecting the glories of the sky and vegetation around, there are often strange and persistent differences in the colours of individual ponds lying quite close to one another. In some of them the water, when clearest, has a bluish green hue, while in others it is deep green, brown, or reddish ; but the colouring produced by the presence of minute particles floating on the surface, or drifting in clouds beneath it, is very much more conspicuous. The materials which cause them to “cream and mantle” with scum (*kāī*, as the natives of India call it) are of very distinct nature in different cases. In most instances they are products of cryptogamic plants, but sometimes they are supplied by higher vegetables, and occasionally they consist of swarms of unequivocal infusoria, or of organisms which are ordinarily regarded as such. As has already been mentioned, they may either present themselves in the form of films or membranes which seem to be strictly limited to the surface of the water, or as clouds of varying density diffused through its upper strata. In certain cases they seem to retain one or other of these characters throughout the whole time in which they are visible, but in others both clouds and membranes are present either simultaneously or alternately. The colouring which they give to the water varies greatly in individual cases, and is often surprisingly vivid ; sometimes it seems

as though one of the plagues of Egypt had revived and "turned the waters into blood"; whilst on other occasions, tints of green, ranging from the deepest olive, cupreous, or bluish, to the brightest emerald; of warm vandyke brown, or even of almost pure white succeed one another or appear in variously mingled proportions at one and the same time. In some cases they only appeal to visual sense, but in others they are endowed with such powerful and usually unpleasant odours that their presence is advertised long before they have become visible, just as in the case of the common stink-horn fungus of English woods it is usually smell and not sight which first intimates the neighbourhood of the plant to the wayfarer. Such offensive scums may almost invariably be effectually done away with by means of pouring enough kerosine oil into the water to form a continuous, thin film over the surface. The oil quickly evaporates, and, unless applied in great and quite unnecessary amount, does no appreciable harm to any ornamental aquatic plants whilst proving destructive to the spores of algæ or the swarms of infusoria which are the cause of annoyance.

In mid-winter the swards of *Vallisneria*, which clothe the soil of the bottom of many ponds, and form dense spiky jungles in the transparent depths, begin to tire of seclusion, and send up hosts of male and female flowers to the surface. The females laboriously climb upwards by means of developing and uncoiling a long spiral stalk, whilst the males are simply detached from the plants and

float up to gather into great rafts, which go drifting hither and thither to apply their loads of snowy-white pollen to the stigmas which they come across in the course of their voyages. It is noteworthy that within the limits of one natural order, Hydrocharideæ, there should be two genera showing such elaborate and unlike means of securing efficient pollination under exceptional conditions as those which are present in *Vallisneria* and *Ottelia*. In both cases the pollen-grains are destroyed by contact with water, and in both they are produced by plants of strictly subaqueous habit. In *Vallisneria* the two classes of sexual elements are the products of distinct plants; but in *Ottelia* they are borne not only on one plant, but within the same floral envelope, and the means securing fertilisation have been elaborated so as to allow for this difference. Had the flowers of *Vallisneria*, like the rest of the plant, remained permanently submerged, the pollen could hardly ever have reached the stigmas in efficient condition, for it must almost inevitably have come into destructive contact with water before arriving at its destination; but the difficulty has been overcome by the ascent of the stigmas to the surface, and the coincident separation of the male flowers to float up and mature there, and so provide for the occurrence of pollination either by direct contact or through the intervention of currents of air or wandering insects. The occurrence of pollination not only serves to secure fertilisation, but acts as a stimulus which causes the long stalks of the female flowers, which, when uncoiled, are often nearly a yard in length,



to roll themselves up again and so descend to the bottom of the water, where the seeds may be matured in a safe and suitable environment. In the case of *Ottelia* the same end—the preservation of the pollen from injurious contact with water—is equally efficiently attained but by entirely different means. In *Vallisneria* the pollination of the stigmas of the female flowers is carried out above the surface of the water, but in *Ottelia* the flowers remain permanently submerged, and are temporarily occupied by local accumulations of gas, within which the process can securely take place; in *Vallisneria* the flowers travel up to the surface of the water to reach the general atmosphere, while in *Ottelia* they are provided with localised subaqueous atmospheres of their own manufacture. In the one case the flowers are forced to go in quest of a gaseous environment, and in the other this is temporarily supplied to each flower beneath the water by means of the localised discharge of large quantities of gases manufactured within the interspaces of the tissues at large and, for the time being, finding the readiest points of exit within the flowers, which are thus converted into little tents, arched over by the incurved petals and forming secure and retired nuptial chambers.

Of all the many coloured scums which occasionally cover the surfaces of ponds in Calcutta one of the commonest and most conspicuous is that which represents the outcome of the resting stages of an organism, *Euglena viridis*, which is ordinarily regarded as an animal, but which in

certain respects shows many algal peculiarities. Hardly any resident in Lower Bengal can have failed to observe the extraordinary differences in colour which are diurnally displayed by many ponds at certain times of year. In such cases the water at midday usually shows merely scattered traces of any distinct scum and is of a dull red colour, whilst in the evening it becomes clothed in a vivid green membrane which gradually acquires a bright red hue on the following morning and then dissolves and disappears. When these transformations are closely studied under low magnifying powers, or even by the unaided eye, various details accounting for their origin may be readily ascertained. In the early morning the red membranes covering the water have a curiously dry, dusty look, and form continuous sheets, which a little later break up and are replaced by shifting reddish clouds drifting about a little below the surface. This state of things persists for the next few hours, but towards noon thin flakes of membrane begin to reappear and then gradually spread out and coalesce, increasing in thickness as they do so, and ultimately forming a continuous covering over a great part or even the whole of the water. This covering at first has a strong red colour, like that of the morning membrane, and gradually acquires a dry and powdery aspect. During the course of the afternoon a series of changes in colour take place; the original pure red diminishes in brightness and begins to show a greenish tinge, and at sunset it has been completely replaced by a uniform and intensely vivid green. After this no sign of farther

change appears until shortly before dawn, when a reverse set of transformations begins to set in and runs its course so rapidly that at sunrise the surface has become as bright red as it was twenty-four hours earlier. In attempting to follow out the various stages in these processes more closely it is necessary to make use of a microscope, but only moderate magnifying powers are required in order to attain a fairly clear idea of the principal events which characterise them and occasion the conspicuous changes in the condition of the water. The study of the subject may be most satisfactorily entered on at the stage at which there is no distinct scum and when the upper layers of the water are thick with shifting clouds of a red colour. When a drop from one of these is examined under the microscope, it is found to be crowded by innumerable active creatures, generally of an elongated oval or pear-shaped outline, each provided with a long motile filament, and containing a bright rose-coloured patch and a considerable number of bright green spheres embedded in a transparent basis of protoplasm which is so full of minute particles of a bright burnt-sienna hue as to give the whole body a strong red tint when viewed superficially. Under continued exposure to sunlight the green spherules increase in size and in depth of tint, but no appreciable change of colour in the body can be detected so long as the small red particles continue to be evenly diffused throughout its substance. At this time all the organisms are in ceaseless movement and swim freely through the water by the aid of the energetic



action of their contractile filaments and the occasional occurrence of amœboid changes of form connected with redistributions of the protoplasmic basis of their bodies. After a time, however, their activity diminishes, their motile filaments disappear, their bodies become spherical, float up passively to the surface of the water and begin to show a distinct separation between cell-wall and content. As more and more cells come up they gradually become closely crowded together, and, as the outer layers of their walls are soft and gelatinous, readily adhere to one another so as to build up continuous membranes consisting of a structureless network representing the fused material of the original cell-walls, and of innumerable encysted protoplasts included in its meshes; the process is, in fact, parallel to that which takes place in some of the lower Algæ in which fronds arise, not as the outcome of repeated divisions originating in a single unit, but as the result of the permanent association of elements which originally were independent of one another.

Some of the cells undergo no change in form, but others grow upwards, losing their original spherical outline and projecting into the air above the level of their unaltered companions so as to give the general surface of the membrane the peculiarly dry and rough character which is so often conspicuous in it under the influence of oblique light. In such cells the protoplasm always occupies the upper part of the cavity, and, as the latter lengthens, climbs upwards with it so that in many cases it ultimately lies at a considerable distance



above the level of the water and the horizontal basis of the membrane. As the protoplasm ascends, the lower part of the cell-cavity contracts and the body as a whole assumes the form of an inverted flask with an empty, transparent neck and a bulb full of living contents. The process of ascent of the cell-wall and protoplasm is often intermittent, and, where this has been the case, the periods of rest leave traces behind them in the form of thickened rings around the inner surface of the neck of the flask ; while, whenever the process has been completed, such rings are replaced by a transverse partition dividing the originally simple cavity into two distinct chambers, the upper one more or less spherical and full, and the lower cylindrical and quite empty. The originally unicellular body is thus transformed into a bicellular one, and the events are such as to suggest that the organism in which they take place is of the nature of a filamentous alga in which continuous vegetative growth has been so much suppressed that at the utmost it only leads to the development of bicellular filaments between successive generations of zoospores.

Shortly after the cells have come to rest conspicuous rearrangements begin to take place in their contents. The protoplasm gradually retracts from the walls of the cavity to form one, two, or even more rounded masses, and at the same time the red granular matter, which was previously evenly diffused, becomes gradually gathered up into a dense heap, allowing the green colour of the large spherules to shine out more and more clearly and so give the membrane as a whole a green in place of

a red tint. A piece of a membrane built up of cells in this state is a most beautiful object when viewed under a low magnifying power and reflected light, for it appears as a bright green carpet bearing numbers of shining colourless columns capped by spheres painted in vivid green and red. After this condition has been reached and a typical green evening scum formed, the only appreciable changes which take place until the following morning are a gradual increase in the amount of the red granular matter and a slight shrinking of the green globules. On the approach of dawn, however, a new set of transformations begins to manifest itself. A renewal of activity sets in; the colourless protoplasm begins to show slow changes in form; and the red granules gradually separate from one another and spread out so as to mask the green of the chromatophores and cause the membrane to resume a red tint. The movements of the protoplasts become more and more energetic; contractile filaments appear, and presently each cell is tenanted by one or more active *Euglenæ*, who, after struggling about for a time within their prisons, break their way out through their walls and swim off to gather in moving throngs in the water.

The wonderful and rapid changes in the tints of these pond-scums are certainly primarily owing to the occurrence of alternating periods of activity and rest and coincident variations in the distribution of coloured constituents in the organisms which unite to build up the membranes; but another factor also comes into play to determine the extreme brilliancy of the alternating hues in

the early morning and late evening; for it can be readily shown by experiment that under exposure to sunshine the green chromatophores increase in size and depth of colour while the red granular matter atrophies, and that in darkness processes of a reverse nature go on. The mere rearrangement of the two sets of coloured materials contained within the cells accounts for the alternating predominance of red and green tints, but the special intensity in which these are alternately present in the hours of early morning and late evening is the outcome of the fact that at the one period the red constituents, and at the other the green ones, have reached their maximal development.

There are certain other peculiar features in these scums which are not so easy to account for as the diurnal changes in colour. One of these is that, in the neighbourhood of Calcutta, the access of water from the Hugli, in whose stream no conspicuous evidence of the presence of *Euglenæ* can ever be detected, seems to exert a most potent influence in determining the invasion of ponds. Isolated ponds may remain for years entirely exempt; but whenever they are either permanently connected with the river or are intermittently replenished by water from it during the dry season, they are almost certain to become infested within a short time. This is a point which merits further inquiry; but it is not the only one to do so, for the strangely intermittent fashion in which the scums appear also calls for explanation. At certain times a pond will, during many weeks, be crowded by myriads of active *Euglenæ* every morning and



covered by a continuous membrane of encysted ones every afternoon and night, and then a period sets in in which it will show no appreciable evidence of their presence. I have made many attempts to fill up this blank in the life-history of the organisms, but always in vain. When water full of active *Euglenæ* or covered by scums of encysted specimens is transferred to large glass jars or earthenware tubs, the normal alternation of the active and resting states continues for a short time to take place; but afterwards persistent encystment sets in, and the resultant membranes sink to the bottom of the water and form a red sediment, in which the contents of a few cells may become resolved into numerous small zoospores; but those of by far the greater number simply die and disintegrate or form the prey of rhizopodous parasites.

There is one thing in connection with the presence of *Euglenæ* in ponds in regard to which I can speak from painful personal experience, and that is that, should any one ever think of bathing in a body of water infested by them, he will do well to keep his head above the surface of the water; for, should it come in contact with his eyes, he is very likely to suffer from extreme irritation or even acute inflammation of the conjunctivæ.

It would demand a whole volume to contain any full and detailed account of all the various organisms which form important constituents of the common scums of ponds in Calcutta. In most cases the predominant elements are of an unequivocally vegetable nature, but occasionally there can be no question—not even the possible doubt



which is present in regard to Euglenal scums—that infusoria are the essential factors. This is strikingly conspicuous in certain deep brown membranes which are almost wholly built up of the closely aggregated bodies of a species of *Peridinium*. It would be hard to say whether algal or infusorial scums are entitled to rank higher in regard to capacity of giving off vile odours, but certainly the *Peridinal* one which has just been mentioned holds a very distinguished place in the cadre.

## CHAPTER XVI

### CHANGES IN COLOUR OF FLOWERS : BARK : PALMS : FIG-TREES : CREEPERS

As the wide-spreading Nyagrodha tree (*Ficus indica*) is compressed in a small seed, so, at the time of dissolution, the whole universe and all things are visible in thee as its germ.

*Vishnu Purana.*

There is one very fair and great Tree growing in that Soil, of special observation, out of whose Branches or great Arms grow little Sprigs downwards till they take Root (as they will certainly do if they be let alone), and taking Root, at length prove strong supporters unto those large Branches that yield them.

*A Relation of Sir Thomas Roe's Voyage into the East Indies.*

To any one new to tropical gardens, the very conspicuous changes in colour which many flowers show at various periods after opening must always be highly impressive. Almost every garden in Calcutta contains specimens of *Hibiscus mutabilis*, *Saraca indica*, and *Quisqualis indica*, all of which afford well-known instances of such changes. In the case of the first of these plants, the phenomenon, although very well marked, is hardly so impressive as it is in the other two, because, as the flowers only last for a single day, their regular change from pure white in the early morning to deep rose in the afternoon may be looked upon as a mere exaggerated instance of the alterations in tint which so often attend the decreasing vitality in

corollar tissues shortly before their death. Similar changes, though in less degree, occur in the flowers of various other kinds of *Hibiscus*, and specially in those of the common "shoe-flower" of Indian gardens, *H. rosa-sinensis*; only it is loss not gain of colour which takes place in it and transforms the vivid red of the morning into a paler and duller tint in the late afternoon. The flowers of many *Ipomœas*, too, are subject to considerable change of colour during the course of the day, and in certain cases the transformation is very considerable. In the case of *Ipomœa tricolor*, for example, the flowers are normally of the purest sky-blue in the morning, but for some hours before they close in the afternoon they acquire a pinkish hue, or may even become as strongly pink as they will be when permanently folded on the following day or as they are when they have opened under unfavourable conditions. The specific names *tricolor* and *rubro-cœrulea* applied to this plant afford a striking example of the strange errors into which systematic botanists may fall when working with dried specimens, or, at utmost, with living plants growing in abnormal circumstances; for, when really healthy and in full vigour, the flowers are neither tri-coloured nor red and blue, but are of the purest, brightest azure save where this tint is replaced by white in the lower parts of the tubes of the corollas. It is doubtless quite true that, like those of other blue or purple *Ipomœas*, the blooms are pink in bud and after they have finally closed; but, so long as they are in really congenial surroundings and have not begun to lose their



PLATE XXII.—PALMS IN AN INDIAN GARDEN.





vigour preparatory to closing, the only colour which they possess is of the purest blue. If, however, the environment be not quite favourable, they often retain the colouring normal to the buds in greater or less degree, and then either pink and white, or pink, blue, and white blossoms occur.

In Calcutta the plants flower in winter, and, whenever the nocturnal temperature happens to have risen beyond a certain point, the normal pure blue flowers are sure to be more or less completely replaced by pink or pied ones on the following morning. Similar evidences of the influence of an unfavourable environment on the chemical processes determining the colours of flowers are afforded by another very common creeper, *Ipomæa Nil*; but in this case it is depression, not elevation, of temperature which causes departure from the normal tint. In this instance the plant is a perennial which produces the greater number of its flowers during the warm, damp weather of the rainy season, and under such conditions they are invariably of a pure dusky blue. A certain number of blooms, however, continue to open throughout winter, and the lower the temperature falls the more do they lose their normal tint and acquire a pinkish one, until eventually most of them show no appreciable traces of blue. But whenever any interruption in the cold weather takes place and the nocturnal temperature reaches the level at which the flowers of *Ipomæa tricolor* become pink, those of *I. Nil* at once begin to resume their normal blue.

In the case of the flowers of *Saraca* (the Asoka of the natives), and *Quisqualis*, the changes in

colour are more remarkable because they cannot be ascribed to any mere depression of the vitality of the tissues connected with the approach of death or the presence of unfavourable surroundings, seeing that they show themselves long before any signs of decadence have manifested themselves, and under perfectly normal conditions. In *Saraca* the flowers remain in full vigour for several days after they have opened; but, whilst at first of a pale ochre tint, they gradually take on a terra-cotta and then a strong vermilion one, so that the hues of the individual blooms in the short thick bunches combine to produce a harmonious and brilliant effect which it is impossible to describe. That the changes in colour are here mainly determined by exposure to sunlight can be readily ascertained by studying the behaviour of the flowers in bunches which are fully exposed, as compared with that of those which are more or less continuously overshadowed by neighbouring masses of leaves.

The alterations taking place in the case of *Quisqualis* are even more striking, as they involve a transition from pure white to very deep red, and are still more unequivocally the outcome of the action of the rays of the sun. The plant is a rampant climber which is to be met with in almost every garden, trailing over trellises, and smothering shrubs and small trees with its exuberant foliage. The flowers are white, pink, or strong red, according to the conditions to which they have been exposed, and are produced in large bunches during the greater part of the year, but in special abundance in late summer and the early half of the

rainy season. Towards the end of June the plant glorifies every object over which it has climbed with wreaths of luxuriant foliage and hosts of white, pink, and red blooms with starry mouths and long slender throats. Whilst in bud the flowers are pure white wherever they have not been exposed to the direct rays of the sun, but elsewhere they are pink or red ; and hence all the buds in bunches of bloom buried beneath heavy masses of leaves are entirely white, whilst those which the sunlight can reach are partly reddened. Owing to the spiral fashion in which the lobes of the perianth overlap one another whilst in bud, each of them which has been subject to direct sunshine is, when first unfolded, pure white above and particoloured beneath, one half of the under surface being white and the other red, according to its previous protection or exposure. When buds, which have been developed in deep shade, and are, therefore, entirely white, are brought into the house and exposed to total darkness, they expand in due course, but never show any appreciable change in colour, and a like treatment serves to arrest the progress of change in specimens which have previously been exposed to sunshine. On the other hand, flowers which are allowed to open on the plant become reddened in degree and rate proportionate to the extent to which they are exposed. The opening of the flowers normally takes place just after the onset of darkness, and each successive crop of newly opened blossoms shows no change of colour until the following morning, when the individual blooms



begin to colour up in direct ratio to the brilliancy of the light and the degree in which it strikes them. A single day of continuous exposure to strong, direct sunshine is enough to dye a flower deep red, but it may take several days to make one which is overshadowed by foliage put on even a faint pink tint. In cases of this kind it seems that changes of colour are directly determined by insolation, and are not the outcome of any alterations in the intrinsic chemistry of the plant.

It is delightful to watch a mass of *Quisqualis* in full bloom shortly after sunset, especially on a brilliantly moonlit night. For a time nothing can be seen but the lights and shades of the tangled foliage, for the colours of the flowers which have previously reddened are invisible in moonshine; but presently the surface begins to show points of white which grow out of the gloom, and are soon transformed into shining stars as bud after bud unfolds in rapid succession. There is always something impressive and seemingly mysterious in any such exhibition of active evolution in darkness. We are so much used, on the ground of our own experience, to associate the absence of light with times of repressed activity as to be apt to forget that there are many "children of the night who wake when mortals dream, and find their common life in those wondrous hours that flow noiselessly over the moveless death-like forms of men and women and children, lying strewn and parted beneath the heavy waves of night, which flow on and beat them down, and hold them drowned and senseless, until the ebb-tide comes, and the waves

sink away, back into the ocean of the dark.” There is, of course, much less excuse for such forgetfulness in the tropics than in temperate regions. In the latter, night, with its deathly stillness, may well be regarded as a time of general rest, but this can hardly be the case in the tropics, where the hours of fullest daylight are often those of deepest silence, and the onset of darkness the signal for a hubbub of animal voices. Even to the end, however—even after long experience of the tumult of animal life in tropical nights—a sense of mystery attends the rapid opening of the blooms of night-flowering plants. The expansion of the great white corollas of *Calonyction*, *Cereus*, and *Nymphæa* is always an impressive event, even after it has been fully realised that it is probably merely the outcome of temporary weakening of masses of tissue containing chlorophyll, which were strong enough to resist the expansive pressure of the surrounding colourless textures so long as they maintained the turgidity acquired under the influence of sunlight, but ceased to be so whenever they were left to rely on mere mechanical strength by the removal of the stimulant which temporarily endowed them with an excess of absorptive property.

The distinctive features in the bark of many tropical trees commonly cultivated in Indian gardens are well worthy of careful study. The stems of the common *Sisus* and *Babūls* (*Dalbergia Sissoo* and *Acacia arabica*), which are so often to be seen growing side by side, are always beautifully sculptured, but the decorative effects which they

present have been attained in two quite distinct ways. In the *Sisus* the trunk and larger branches are scored by narrow longitudinal fissures connected by short, irregular transverse ones, so that the bark is broken up into quadrangular or oval flakes, which as they age tend to curve outwards at either end and accentuate the roughness of the surface (Plate XX.). In *Babūls*, on the other hand, the fissures are very wide, and the surface ultimately comes to be covered by a continuous network of ridges bounding fusiform and lozenge-shaped hollows corresponding to the narrow clefts in the bark of the *Sisus*.

The rind of those palms in which the bases of the leaf-stalks separate from the stem whenever the fronds fade is often wonderfully beautiful, not so much in itself as on account of the way in which it is embroidered by lichens of various colours (Plate IX.). This is particularly striking in the case of the great swelling columns of *Oreodoxa regia*. In them the whole surface is usually mapped out by black wavy lines, separating irregular patches of dark grey, silvery white, ochre, or strong yellow, which in wet weather are further variegated by numerous greenish streaks. Here and there sheets of foliaceous lichens, chalky white, pale green, and bright yellow, or tufts of grey shrubby species rise above the level of the rest of the coating. In many cases the colouring is more or less distinctly banded horizontally owing to the presence of slightly depressed rings, indicating the sites at which leaf-stalks were formerly attached to the stem, and occupied by crusts of grey or whitish



growths, whilst the intervening ridges are clothed in rough yellow ones. The tissues of the trunk beneath this Joseph's coat are greatly subject to the attacks of large boring grubs, who cast out long granular brown tubes from the mouths of their caverns; strange long-legged vermilion and black bugs stalk about over the lichens or fly from one tree to another; droves of red book-lice crowd together and reflect the sunshine from their great glassy wings; and in the case of dead stems from which the rind has begun to flake away, curious pointed chrysalids lie enclosed in cases built up of fragments of lichen. Up aloft, close beneath the plummy crowns of living trees from which leaves have recently fallen, the shafts are painted in rings of burnt-sienna and strong umber, separated by narrower dotted lines of dark brown marking the ends of the vascular bundles which formerly passed outwards to the fronds; but this banding is soon obscured by a green coating of algal cells, and a little later the whole surface is occupied by the common lichens covering the lower parts of the stem.

Palm-stems of this kind are wonderfully beautiful, but they can hardly compete with those in which the bases of the petioles are persistent after the upper parts of the leaves have fallen or been removed and clothe the surface in a continuous layer of scales, arranged in intricate spirals and affording resting-places for the seeds of epiphytes in which they may sink down into recesses full of damp leaf-mould, and on germinating cover their host with a mantle of varied foliage. Almost every



garden in Calcutta contains date- and *tadi*-palms, which in themselves are miniature gardens where figs, orchids, ferns, and many other plants have made use of the hospitality offered by the armoured stems. In many cases the guests are quite harmless, but this is by no means so when they are figs, for these sooner or later surround their hosts with strangling networks of aërial roots, which press more and more closely inwards, and at the same time spread out over the surface and fuse with one another to form a continuous and steadily thickening sheath, from the upper part of which quantities of branches shoot up around the crown of the palm and eventually overtop it. When an accident of this kind has overtaken a tall palm, and the fig has established itself low down on the stem, the upper part of the host is for a long time to be seen rising out of the midst of a grove of branches belonging to the intruder. It was the inconsiderate observation of cases of this nature which once led an innocent youth to remark that in the district in which he was stationed the date-palms had a very curious habit of growing on the top of fig-trees !

There can be no question that the bark of certain kinds of trees is much oftener and more extensively overgrown by lichens than that of others is, but it is by no means easy to account for the fact. In many cases the degree of liability cannot depend on the extent to which the surfaces provide facilities for the reception and retention of algal and fungal cells, for very rugged barks are often almost exempt, and many smooth ones are particularly subject to

attack. The rough stems of *Sisus*, *Babūls*, and *Mahoganies* are hardly appreciably affected, whilst the relatively smooth *Garjans* (Plate XXI.) are invariably thickly clothed in layers of silvery grey lichens, and the exceptionally even bark of *Cochlospermum Gossypium* forms a favourite site for several crustaceans and shrubby growths of varied and often brilliant colours. The relative proportions of the fungal and algal elements in the lichenous coverings of the stems of trees in the tropics, or at least in tropical regions with a well-defined rainy season, vary greatly at different times of year. During the rainy season, when the air is constantly highly charged with moisture and the bark often soaked by heavy showers, the algal cells multiply very rapidly and impart a more or less decidedly green hue to the growths; but in periods of prolonged drought this is replaced by various shades of brown, grey, yellow, or white owing to temporary predominance of the fungal constituents. Particularly conspicuous changes of this nature take place in cases in which the algal constituents of a lichen are normally of a filamentous form, and, even after they have become the commensals of fungi, retain the power of producing their proper fructification. Nothing can be more striking than the seasonal changes in aspect of the patches which so often disfigure the leaves of many tropical plants, and which are caused by the presence of epiphytic and parasitic algal growths, subject to invasion by intrusive fungi. During periods of continuously rainy weather the discs of algal cells increase in size, and at the same time

become invisible even at a short distance, owing to the bright green tint which they acquire ; under the influence of diminished moisture they become first yellow and then strong orange, in consequence of changes affecting the contents of their intrinsic cells, but it is only when they have been invaded by fungi or have withered that they form a conspicuous white eruption over the surfaces of the leaves.

Most gardens in Calcutta contain palms (Plate XXII.), and especially specimens of the four commonest Indian palms—the coco-nut (*nāriyal*) ; the palmyra (*tar*) ; the Indian date (*khajūr*) ; and the betel-nut (*supārī*)—all of which, under certain conditions, and especially where they have not been deformed by human beings in quest of drink or thatch, are highly decorative objects. All of them, save the *supārī*, which is carefully cherished for its nuts, are subject to injury as taps from which toddy may be drawn : but whilst in the neighbourhood of Madras the coco-nut forms the great source of supply, in Lower Bengal the *tar* and the *khajūr* are the chief sufferers. The only one of the three whose appearance is seriously injured by tapping is the *khajūr*, for whilst in the other two trees the stalks of the inflorescence alone are divided, in it the tissues of the stem are so deeply incised that the shafts soon become irregular, and the crowns distorted and abortive. In the case of the coco-nut and *supārī* the stems are almost from the outset smooth and clean, because the leaves fall very soon after dying ; but in the *tar* and the *khajūr* the leaf-stalks are so firmly and intimately connected





PLATE XXIII.—FLOWERS AND FRUIT OF AN ARENGA.





with the stems as to remain adherent for a very long time. The outer parts of such adherent leaves are almost sure to be soon cut away in order to furnish thatch or fuel, but the lower ends remain for years to form a continuous coating of scales and furnish resting-places for the seeds of figs and other epiphytes. It is rarely that the smooth stems of coco-nuts or *supārīs* are to be seen bearing epiphytes or rising over the tops of suffocating fig-trees, but almost every *tar* or *khajūr* is, if neglected, sure to be sooner or later attacked.

Of these common palms the *tar* is perhaps the least attractive, unless indeed attention be confined to the magnificent armour of the scale-covered stems of the younger trees. After this has fallen off, the shafts have a strangely arid, hidebound look, while the crown of great fans above is generally dingy and pallid. It is only in early morning or late evening, when the level light strikes upon the fading fronds hanging down beneath the grey-green masses of the living ones, or when each tree stands up solemnly against a glowing western sky that they are really effective features in a landscape. Many of the trees in the neighbourhood of Calcutta are, however, rendered interesting owing to the fact that they carry numerous nests of the common weaver-birds, who seem to regard the stiff points of the great rigid leaves as the most desirable objects in the locality to play the part of foundations for their pensile edifices.

*Supārīs* are perfectly beautiful so long as they are young and, as Sir Joseph Hooker has it in his ever-delightful *Himalayan Journals*, "like

arrows shot down from heaven," but in older trees the small crowns seem somewhat poverty-stricken, and inadequate to cap the towering slender columns of the stems. This, however, only holds good of isolated trees, for in thick groves, such as those which abound in Eastern Bengal, the crowns unite to form a verdurous roof, supported by innumerable slender shafts and overshadowing mazes of narrow aisles.

Aged coco-nut trees are open to the same criticism, although in less degree; but all those whose crowns are still in full vigour are always admirable owing to the way in which their great feathered fronds are arranged—those in the centre thrown aloft in superbly aspiring fashion, and the lower ones bending farther and farther outwards and downwards, until close to the sides of the stem, the fading leaves hang straight down in plumes of brown and ochre. Any enthusiastic disciple of Herbert Spencer who has carefully studied the *Principles of Biology* in a region abounding in coco-nut-trees is likely to have had his faith in the infallibility of his idol rudely shaken when he comes to the following passage: "For some years it [the coco-nut] goes on shooting up without any signs of becoming fertile. About the sixth year it flowers; but the flowers wither without result. In the seventh year it flowers and produces a few nuts; but these prove abortive and drop. In the eighth it ripens a moderate number of nuts; and afterwards increases the number until in the tenth year it comes into full bearing. *Meanwhile, from the time of its first*





PLATE XXIV.—STEMS OF TADI-PALMS.





*flowering its growth begins to diminish and goes on diminishing until the tenth year, when it ceases."*

Almost every resident in Calcutta must have been personally acquainted with many coco-nuts which went on growing vigorously for more than ten years, and, most assuredly, no one ever saw one shoot up to a height of eighty feet—a height which they often attain—in the course of such a period. The statement affords a striking example of the glaring blunders into which even the most profound and brilliant thinkers may fall in dealing with matters of which they have no intimate or practical knowledge. It is, doubtless, quite true that the leaves of aged coco-nuts, like those of many other old trees, are not so large as those of the young plants, and it may be that the lower part of the stem has reached its utmost girth by the time that a tree has come into full bearing, but, as the inflorescence is not a terminal one, growth by no means ceases with this, and continuous increments of height are added so long as the crown produces fresh crops of leaves.

Common Indian date-palms as grown in gardens and protected from the outrages of toddy-drawers and thatch-collectors, are always highly decorative objects whether they stand out in open spaces or raise their richly plumed heads among surrounding trees and shrubs. Until very old, their stems retain an armour consisting of the bases of past generations of leaves, and therefore rarely present the stiff and naked outlines of those of *supārīs* or coco-nuts. This advantage is, of course, for some time shared by *tars*, but the stiff and pallid crowns of the latter

cannot compete with the masses of waving plumes which cap the stems of fine date-trees, and at certain times of year are glorified by the presence of huge bunches of golden fruits, glowing in the sunlight and eagerly rifled by many species of birds, who do not object to their strongly astringent flavour. The displays of bloom and fruit in this case are certainly very fine, but they pale before those exhibited by certain other kinds of palms; the suicidal extravagance of a *Corypha*, when it decks itself with a terminal plume of inflorescence thirty feet in height, provides a show which, once seen, can never be forgotten; and *Arengas* and *Caryotas*, although not so lavish in their expenditure, produce results almost as striking and certainly more beautiful (Plate XXIII.).

There is one point in regard to palms in which the bases of the leaves remain long adherent to the stems which is almost certain to attract the attention of any one acquainted with the elements of systematic botany. Formerly, at least, considerable weight was laid on the direction of the spirals in which the leaves of many plants are arranged along the course of the stems and branches, and the presence of a right- or left-handed spiral was regarded as a feature of almost specific value. But a very brief acquaintance with palm-stems clothed in persistent scales suffices to show that in many cases the apparent spirals in which these are arranged follow reverse directions in different specimens of one and the same species, even when growing side by side and under seemingly like conditions. Many very striking examples of this



PLATE XXV.—FIG-TREES BREAKING UP A BUILDING.





fact used to be present in a long avenue of *tars* in the Botanic Garden in Calcutta, and one of these is figured here as it appeared about sixteen years ago (Plate XXIV.). From the extremely intricate fashion in which the broad bases of the scales overlap in such cases it is a very difficult matter to unravel the precise details of their mutual relations, but a glance at the present illustration is enough to show very clearly that, in so far as outward aspect goes, the direction of the spirals is of no specific import in the case of some palms.

The commoner fig-trees of Indian gardens are such familiar objects that it may seem unnecessary or even impertinent to allude to them, but just because they are so common they are apt to be undervalued and to receive much less attention and admiration than they deserve. Pipals (*Ficus religiosa*) are beautiful at any time of year; even when, for a day or two, they are leafless, they are superbly decorative in delicate tints of smooth bark, far-reaching boughs, and delicate tracery of twigs; and, in the case of great old trees, owing to the clustering columniation of the huge trunks. The wide reach of the horizontal boughs, which are very rarely provided with any secondary stems and usually only acquire adventitious support when they bend down so far as to touch the ground, renders them somewhat dangerous as roadside trees; for the wood is brittle and often attacked by great boring grubs who may carry their mining so far as to cause whole branches to fall under the weight of their own foliage even in fine and still weather when there is neither high wind nor

drenching rain to give any warning of the likelihood of such a catastrophe. A tree in this condition overhung the approach to one of my laboratories in Calcutta, and more than once startled me by the rending crash announcing the fall of a great bough upon the roadway. That an old pipal can very fairly hold its own as a feature in a winter landscape against most English oaks is, I think, fairly shown by the illustration in Plate XIX. The foliage is almost always astonishingly beautiful; when it first unfolds it has a delicate silken sheen and is dyed in the brightest hues of rosy pink, bright bronze, and emerald green; as it matures it becomes strong deep green and acquires a polished surface which glitters or seems to emit little tongues of flame where the light of the sun or moon is reflected from it; and even in fading it is usually brave in varied shades of yellow and brown. Pipals are very garrulous trees; for whenever the gentlest breeze travels over them, the long, pointed tips of the hard leaves, which swing freely on their slender stalks, tap gently on the surfaces of neighbouring blades and make a pattering, exactly like that caused by a heavy shower of rain and both refreshing and exasperating when heard during a baking day or suffocating night in the hot weather. The sound which may be heard beneath a black poplar is somewhat of the same nature, but it wants the distinct articulation caused by the contact of the hard, slender points and polished surfaces of the leaves of pipals.

During the early part of the rainy season hosts of baby-pipals come up, and often in very incon-

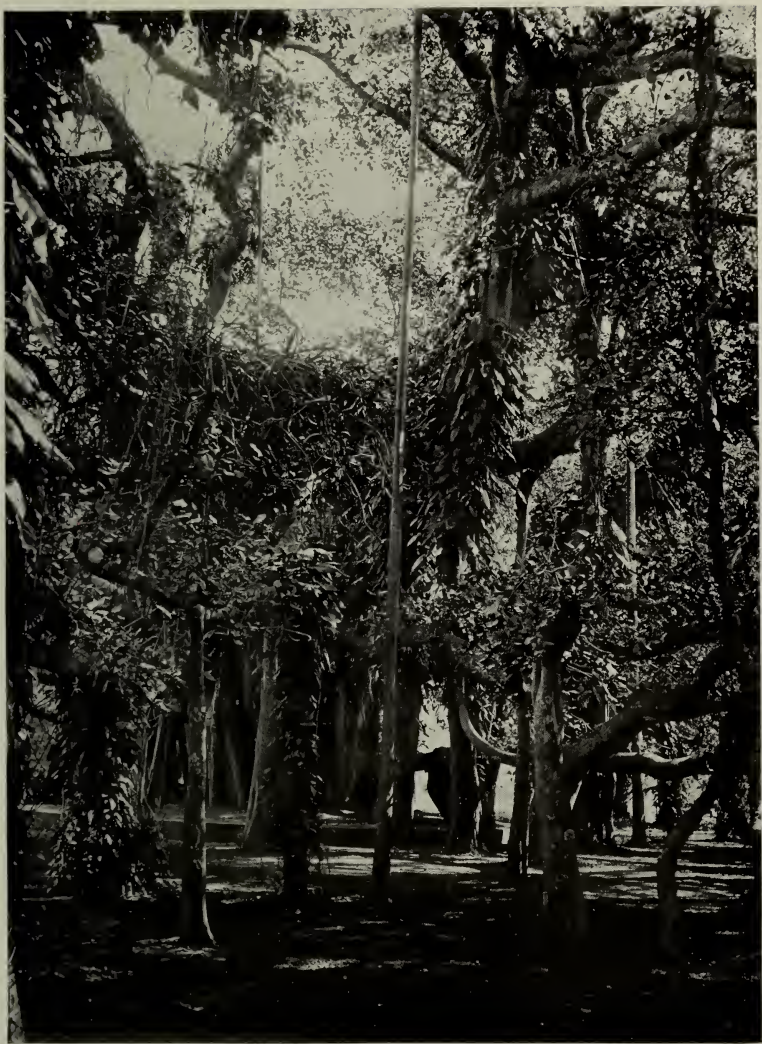


PLATE XXVI.—UNDER A GREAT BANYAN-TREE.





venient places ; for many birds find the fruits most alluring food and spread the seeds broadcast on the branches and stems of trees and the roofs and walls of buildings. The young plants are often very undesirable epiphytes, and always dangerous to the stability of masonry owing to the wonderful abundance and vigour of their roots, which run in networks over the surface and force their way into any cracks or interspaces where the texture is weak (Plate XXV.). When a seedling is detected soon after it has established itself it is easy enough to dislodge it, but a little later this is no longer the case. The so-called " roots " are really in great part descending branches from which not only true roots but leaf-bearing shoots originate, so that it is useless merely to cut away those which lie on the surface. Indeed, to do so is usually a sure means of increasing the mischief, as it only rouses the buried parts to greater activity in burrowing and branching until they reach a fresh site at which to produce new leafy shoots. Careful cutting back, followed by free treatment with poisonous liquids, such as the " Weed-killer " so often used in English gardens in order to keep paths clean, might probably be effectively repressive, but otherwise the only remedy is to break up the masonry until the whole network of intrusive roots can be extracted. Growths of this kind are not only injurious to masonry, but are apt to be dangerous owing to the way in which they often cause the sudden fall of large masses of bricks and mortar. Before I became the tenant of it, my last house in Calcutta had been invaded by two

fig-trees—a pipal and a banyan—which had been allowed to establish themselves firmly just over the heavy projecting cornice beneath the parapet of the terraced roof. All attempts at getting rid of them by repeated cutting proved futile; but one ultimately eradicated itself by splitting off the mass of masonry which it had penetrated, tearing out the ends of its roots from the neighbouring wall and falling along with its support to the ground below. Fortunately no one was directly beneath at the time when the catastrophe took place, but the sight of the heap of plaster and brickbats was in itself a very filling warning of the dangers which may attend the presence of such mischievous guests.

Large banyan-trees are always highly impressive and acquire a very special interest at times when they are covered by yellow and scarlet ripening fruits which attract hosts of birds, squirrels, and fruit-bats. When viewed from a little distance they are by no means striking objects whilst in full vigour, for they then appear as mere low mounds of dark green foliage, descending almost to the surface of the ground and rising in gentle curves to a central flattened dome. The outer ends of the great horizontal boughs sink so low that it is only after they have been passed that the wonderful nature of the tree can be justly appreciated (Plate XXVI.). The experience is somewhat like that of passing from the ungainly outside of Santa Sophia into the overpowering coloured gloom beneath the dome. In the case of a great banyan-tree, the knowledge that such a monstrous heap of foliage is the product of a single plant may be



XXVII.—A DECORATIVE FIG-TREE.





surprising, but it is only when the labyrinth of columned aisles converging upon the parent trunk comes into view that mere wonder is translated into admiring awe. Long shadowy corridors cross one another in every direction, bounded by countless pillars, which in some cases rise clear and smooth from base to summit, and in others are clothed in luxuriant masses of the foliage of creepers and epiphytes (Plate XXVIII.). On looking directly inwards towards the centre of the tree the shafts appear to be arranged in converging files corresponding to the lines of the great radiating branches overhead; some of them have already become massive secondary stems; others appear as slim pillars or slender cords, which are limp and flexible so long as they have only recently succeeded in anchoring themselves, but presently after become so tense as to yield a musical note when struck; whilst all around bundles of threads with pinkish tips are feeling their way downwards from the great branches overhead towards the soil. On looking up, the eye meets a huge canopy of foliage, in some places so thick as to form an impenetrable screen, and in others thin enough to allow the outlines of individual leaves to be clearly projected against the sky, and here and there broken by irregular openings through which shafts of sunshine fall, striking athwart the grey stems and hanging roots and spreading out over the ground on a surface strewn with fallen leaves and fruits scattered among tufts of mosses, ferns, and other shade-loving plants. During times at which the fruit is ripening, the hush which usually prevails

beneath such a tree is replaced by a continuous softly-pattering sound owing to the showers of figs broken off or dropped by the squirrels, barbets, koïls and other birds who are for ever among the branches squabbling with one another over the stores of food which they provide. When dealing with great banyan-trees it seems only right to mention that any one who visits one should keep a sharp look out for the seedlings which occasionally appear on the ground in place of on buildings or trees ; for, according to native belief, such exceptional specimens ought to be at once secured and swallowed in order to procure longevity.

Of all the common fig-trees of the gardens of Calcutta *Ficus comosa* is perhaps the most attractive ; for, though it never attains the superb dimensions of large pipals or banyans the beauty of its heavy tresses of shining green leaves falling over one another in showers of verdurous luxuriance would be hard to match, more especially at those times of year when the fruits shine out amid the surrounding green like little golden pears, which are not only fair to see but have the added merit of being highly attractive to green pigeons, so that any place in which they abound is almost sure to be visited by flocks of these charming birds, who, when they suddenly take wing, like those mentioned in *Phantasmion*, might almost be mistaken for flying leaves, so closely does the colour of their plumage match that of the surrounding foliage. Some of the smaller figs, such as that shown in Plate XXVII., are highly decorative features in gardens owing to the large size and beautiful contour of their leaves.

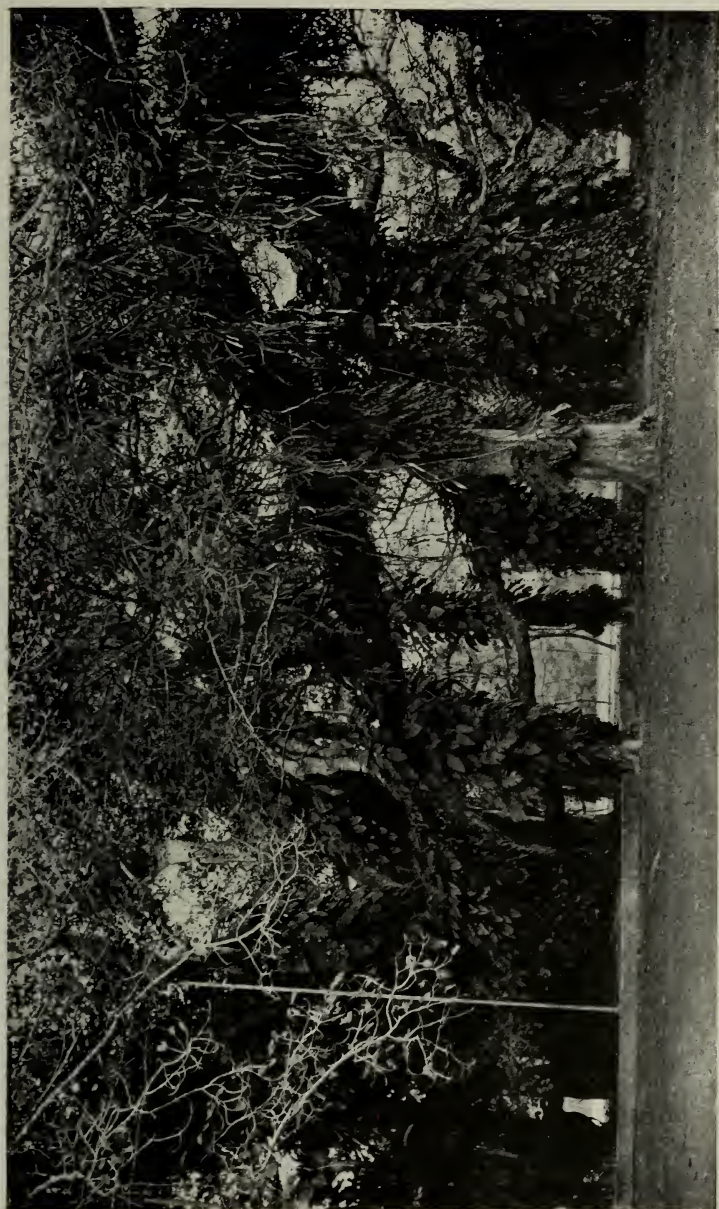


PLATE XXVII.--CREEPERS ON A BANYAN-TREE.





Tropical gardens almost always abound in creepers, which are often of inconvenient size and luxuriance (Plate XXVIII.). In the gardens of Calcutta there are very few of them to rival *Beaumontia grandiflora*, which smothers the tops of the tallest trees with its great rough leaves and bunches of snow-white blooms. It is particularly decorative where it has been allowed to ramble at will over a large silk-cotton tree; for, as both it and its host flower at the same time, there is a period every spring when the tree is brave in hosts of large red and white blossoms, making it more like a gaily coloured Japanese drawing than anything in "this work-a-day world." *Petræa* is quite unique in the refined beauty of its violet and lavender inflorescence, whether draping the summits of lofty trees or forming tangled shrubberies which, when in full bloom, make the passer-by feel as though he had suddenly stepped out into the sky. *Congea tomentosa* (Plate XXIX.) is another creeper of wonderful beauty when decked in its peach-coloured plumes, and so, too, are many of the commonly cultivated Bignonias. Bougainvilleas are doubtless very showy as masses of brilliant colour, but unfortunately the species (*B. glabra*) which grows most readily and luxuriantly in Calcutta has bracts of a saturated and outrageously aniline purple, which swears at almost every other colour save that of the pale primrose flowers. The colouring in *B. spectabilis* is, however, much less offensive, and that of another species is quite admirable in its warm terra-cotta. Passion-flowers of many kinds

flourish, and some of them have run wild and are to be met with as roadside weeds. Among these naturalised species *Passiflora fœtida* is conspicuously ornamental from the way in which it smothers the hedges in masses of bright green leaves and green and white blooms set in mossy involucre.

Convolvulaceous creepers abound everywhere, covering whole shrubs and trees, and even, in the case of *Ipomœa reptans*, trailing out for fathoms over the surfaces of ponds and opening large pink flowers among those of water-lilies and other aquatic weeds. Some species are particularly interesting on account of the strange purposive reactions with which they respond to exposure to abnormal conditions. In the days of my youth and inexperience as an Indian gardener I had a severe struggle with one of these seemingly intelligent vegetables. Some of the largest and most rampant species very soon injure trees which they have invaded by covering the foliage so thickly as to interfere with its free exposure to light and air; but, in happy ignorance of this fact, I planted an *Argyreia* at the foot of a fine pipal in my garden. The site proved to be quite congenial, and within a very short time the plant had reached the top of the tree and begun to overwhelm it in masses of its own great leaves. Attempts at arresting the mischief were at once undertaken, the roots of the creeper being dug out and the cordage of ascending stems cut away as high as it could be reached. For a time all seemed to be going exactly as was desired, for the leaves withered and fell, leaving those of the pipal once



PLATE XXIX.—*Congea tomentosa* IN BLOOM





more freely exposed. But the battle was by no means won ; for presently numbers of slender roots were to be seen descending from among the branches and feeling their way down through the air to the soil beneath, and it was not until these had been repeatedly cut back that the plant threw up the sponge and ceased to struggle for existence. An event of this kind is certainly very striking in the evidence which it affords of the presence of an exceptional capacity for sudden accommodation to abnormal conditions. When we find a plant, which ordinarily shows no inclination to form adventitious roots, suddenly producing them in large numbers under conditions calling for their presence, but at the same time apparently adverse to the evolution of any considerable masses of new tissue, there is a great temptation to regard the event as the outcome of an exceptional retention of Beccari's "plasmative phase," or, in other words, as the result of an active exercise of intelligent volition.

Gardeners in the tropics have many difficulties to contend with, but they have at least one great advantage over their fellows in temperate regions, for they are never called on to exercise much patience in awaiting the outcome of their toils. This, of course, holds good particularly in relation to the planting of trees. When any one in the British Islands lays out an avenue he can hardly ever expect to witness the full effect of his work, but in the tropics stately avenues arise in the course of a few years wherever suitable trees are made use of. The avenue of *Pithecolobiums*, represented in Plate XXX., was planted several years after I

first arrived in Calcutta, and was cut down to make room for other trees several years before I left India; and a solitary seedling of the same species which I planted in the spring of 1882 was a great tree, about sixty feet high and with a proportionate spread of boughs, only a little more than ten years later.

It would be almost impossible to give any adequate account of the glories of all the common flowering shrubs and creepers which month after month fill Indian gardens with rich and varied colours. The vaguest memories of them excite *sehnsucht*, and any attempts at description must almost inevitably make for disgust and acute home-sickness; modern British gardens are often miracles of skilful culture and successful conflict with difficulties, but in certain respects they can never compete with those in tropical regions. In any case, however, it is high time that these notes should come to an end:

“ Bornons ici cette carrière,  
Les longs ouvrages me font peur ;  
Loin d'épuiser une matière  
On n'en doit prendre que la fleur.”

To any one who attempts a record of some of the happiest experiences of a life spent in a country which must surely be more or less regarded as “home,” the temptation to continued narrative must always be great; but, as Milton says in the “Hymn of the Nativity,” “time is our tedious song should here have ending”—the feelings of possible readers must be considered, and to such idols I tender sincere apologies for the imperfection and extension of the foregoing pages.

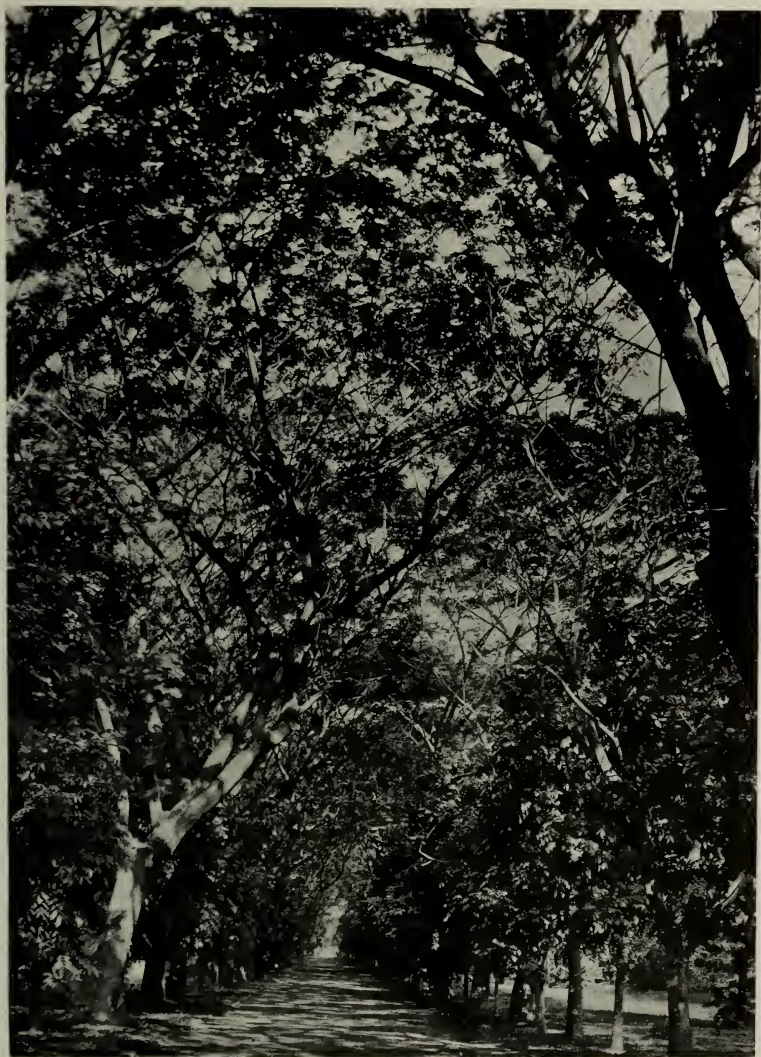


PLATE XXX.—AN AVENUE OF RAIN-TREES.





## APPENDIX

### FIGS AND FIG-INSECTS

WHILST the evolution of the wonderfully elaborate correlation between figs like *Ficus Roxburghii* and the insects infesting them must meanwhile remain an enigma, there are certain facts which may possibly serve as a clue towards its ultimate solution. These are: 1st, that the present interdependence of the animal and vegetable organisms is so fully worked out as to imply that it is the outcome of processes of very remote origin; 2nd, that it is not at all likely that the insects should have primarily acquired a habit of visiting fruits so efficiently closed as those of figs now are; 3rd, that the access of insects occasions excessive nutrition in both kinds of fruits; 4th, that staminal flowers are confined to the edges of the gall-fruits, and that many of them show rudimentary ovaries and stigmas; 5th, that the embryos developed in the flowers of the female fruits after the access of insects are of parthenogenetic nature.

The probably remote origin of the relation between the insects and fruits, and the unlikelihood that practically closed cavities should have invited attack by insects devoid of any efficient means of entering them render it possible to assume that, when first infested, the fruits had not yet acquired their present form, but resembled those of *Dorstenias*, or, at all events, possessed cavities communicating freely with the environment. Allowing this, and that the receptacles had already acquired distinct sexual characters, so that one set of them, borne by one set of trees, produced only staminal flowers, and another, belonging to another series of trees, contained only female flowers, it is clear that the access of stinging insects, attracted, like

Pheidole, by the presence of abundant stores of food for their young, and puncturing the tissues so as to cause a reactive rise in nutritive supply, must have produced some results.

So long as the cavities of the receptacles remained freely open and attack took place after the flowers had matured, it must have favoured the transfer of pollen from male to female fruits and the occurrence of normal processes of fertilisation. But in any cases in which the fruits were attacked whilst still in an embryonic condition the attendant irritation and reactive hypertrophy may well have resulted both in an alteration in form of the receptacles, and in modification of the characters of the flowers contained within them.

It is not at all unlikely that hypertrophy might serve to cause the fruits to assume the form which they now possess, and there is unequivocal evidence that in certain animal and vegetable organisms the nature of the sexual apparatus which they will produce is to a very considerable extent determined by conditions of nutrition; excessive nutritive supply favouring the evolution of female elements, and starvation telling in favour of the development of male ones. Strasburger, in *Die Stofflichen Grundlagen der Vererbung*, points out that many starved prothalli produce only antheridia; that in female plants of *Melandrum album* and *M. rubrum* attacked by *Ustilago violacea* the flowers produce stamens; that in some monœcious phanerogams, such as maize and water-melons, defective nutrition is attended by the evolution of male flowers only; and that, whilst aphides persistently lay only female ova of parthenogenetic property so long as they are in the enjoyment of the unlimited nutritive supply which is at their disposal in summer, they begin to deposit normal male and female ova when autumn leads to its decadence. A specially striking example of the influence of nutritive supply on the evolution of sexual elements is furnished by orchids like *Vanda Roxburghii*, in which the flowers remain essentially unisexual until the access of pollen to the stigmatic surfaces occasions a great rise in nutritive supply and activity followed by general hypertrophy of the ovaries and the development of ovules on the placentas. In the absence of pollination the ordinary conditions of nutritive supply

serve to provide for the evolution of floral envelopes, stamens, stigmas, and placentas, but the tissue on the surface of the latter remains purely embryonic unless hypertrophy sets in in consequence of the stimulant effect occasioned by the application of pollen to the stigmas. The ordinary nutritive supply provides for the development of male flowers, but, in order that these should become hermaphrodite, hypertrophy incident on pollination must intervene.

Let us next consider these facts in reference to the question of the effects which would be likely to occur in embryonic, hypothetically unisexual fruits of ancestral specimens of *Ficus Roxburghii* when subject to hypertrophy excited by the attacks of insects. In the case of male fruits the excessive nutritive supply might well tend to occasion the replacement of staminal flowers by female ones. The latter, however, need not necessarily have precisely resembled those which are now to be met with in normal female fruits, for these are structures produced by organisms which for untold generations have been subject to the influence of extrinsic stimulation well fit to induce important changes which may ultimately have acquired hereditary value. It is, therefore, quite possible that the normal female flowers of the present day differ considerably from those which were present in the ancestral fruits, and that the so-called gall-flowers of the male receptacles may in certain points, such as the form of the stigmas and the thinness of the walls of the ovaries, approach the ancestral type more closely than they do.

Be that as it may, there are certainly some grounds for believing that the pseudo-female flowers of gall-fruits may represent the utmost outcome of a process of sexual substitution which reveals itself in less degree in the presence of embryonic ovaries and stigmas in many of the persistent staminal flowers. The peculiar distribution of the latter within the receptacular cavity may be regarded as evidence in favour of such a view; for the sites which they occupy correspond with those parts of the surface which are farthest removed from the axis of the parent tree—the staminal flowers are situated exactly where any abnormal excess of nutritive supply derived from the axis would be feeblest, and



so either incapable of producing any appreciable result, or, at utmost, only sufficient to provide for the occurrence of imperfect processes of substitution.

There is, of course, no reason to suppose that the hypertrophy induced by the access of insects to embryonic female fruits would occasion any sexual substitution, but it must have produced some effects, among which it is quite possible that a protective thickening of the walls of the ovaries and a capacity for parthenogenesis in the ovules, like that possessed by the ova of highly nourished aphides, may have been included.

It certainly seems to be possible that hypertrophy excited by the attacks of insects might suffice to transform embryonic normal male and female receptacles into mature fruits resembling those which are now produced independent of any extrinsic agency; but—and here what to many will appear a fatal objection comes in—unless we assume the possibility of the fixation and hereditary transmission of the peculiarities originally acquired through the intervention of the insects, there is nothing to account for their spontaneous occurrence at the present time. Unless fixation and hereditary transmission came into play at a certain period, every successive crop of budding receptacles would only have provided embryonic tissues subject to certain definite evolutionary modifications when attacked by insects, but there could have been no spontaneous development of gall- and female fruits such as that which at present occurs.

But, even if it were granted that embryonic male and female receptacles of ancestral specimens of *Ficus Roxburghii* subject to hypertrophy would probably give origin to mature fruits resembling those which are now spontaneously produced, and that such acquired peculiarities may have ultimately become hereditary, it would still be necessary to explain why the fruits should now present fixed characters in spite of the fact that the stimulus which is assumed to have originally determined the occurrence of modifications in their ancestors continues to be applied to them. The hypertrophic stimulus supplied by the access of insects is assumed to have produced certain definite results up to the period at which hereditary

transmission set in, and it is necessary to show some cause for its then ceasing to do so.

In dealing with this question it must be borne in mind that, though the stimulus continues to come into play and to give rise to hypertrophic results, it is now never applied to embryonic receptacles because the floral surfaces in these are inaccessibly buried in the centres of virtually solid masses of tissue. So long as the fruits retained the form which they are assumed to have originally possessed, their floral surfaces must have been exposed to attack at any stage of their evolution; but, whenever they acquired their present one, this would no longer be the case; and, as it is, even the very limited facilities which they actually offer to the access of insects are only provided when they have opened out and become hollow, an event which does not ensue until their contents are no longer embryonic, but have already acquired their essentially distinctive features. Moreover, by the time that fruits providing flowers specially adapted to accommodate the ova of insects or provided with parthenogenetic powers had come to be hereditarily developed, any hypertrophic supply would be fully expended in providing for the nutrition of young animals or plants without inducing farther modifications in the flowers containing them.

It was assumed at the outset that the fruits when first attacked by insects differed considerably from those which are now spontaneously produced, and an attempt has been made to show that the characters of the latter may have been acquired in consequence of hypertrophic changes. But any such changes would almost inevitably give rise to corresponding alterations in the relations between the correlated organisms; for the modified female fruits would no longer provide facilities for pollination or suitable accommodation for ova. In spite of this, however, the continued reproduction of successive generations of figs and insects has been in no way interfered with, because of coincident acquisition of parthenogenetic property in the flowers of the female fruits and of ample accommodation for ova in the substitutionary gall-flowers of the male ones.

The theory which is here advanced can make no pretension

to be a conclusive one; it is confessedly weak in several points and very weak in at least one. It is to be taken as purely tentative, and is only published in the hope that certain of the facts and arguments which have been adduced in connection with it may possibly aid in the elaboration of some more satisfactory solution of the problem with which it deals.

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